SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FRIDAY, JULY 4, 1902.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE PROBLEM OF CONSCIOUSNESS IN ITS BIOLOGICAL ASPECTS.**

OUR Association meets in Pittsburgh for the first time. We are glad to indicate by our assembling here our appreciation of the immense work for the promotion of education and science which has begun in this city and already is of national value. It has been initiated with so great wisdom and zeal that we expect it to render services to knowledge of the highest character, and we are glad to be guests of a city and of institutions which are contributing so nobly to the cause of science.

We may congratulate ourselves on the bright prospects of the Association. Our membership has grown rapidly, and ought soon to exceed four thousand. Every member should endeavor to secure new adherents. For our next meeting we are to break with the long tradition of summer gatherings, and assemble instead at New Year's time, presumably at Washington. To render this possible it was necessary to secure the cooperation of our universities, colleges and technical schools, to set aside the week in which the first of January falls, as *Convocation Week* for the meeting of learned societies. The plan, owing to the cordial and almost universal support given by the higher educational institutions, has

* Address of the President of the American Association for the Advancement of Science. Pittsburgh Meeting, June 28 to July 3, 1902.

been successfully carried through. For the winter meetings we have further succeeded in securing the cooperation of numerous national societies. The change in our time of meeting is an experiment which we venture upon with the greater confidence, because of the success of our present meeting in Pittsburgh.

For my address this evening I have chosen the theme: 'The Problem of Consciousness in its Biological Aspects.' I hope both to convince you that the time has come to take up consciousness as a strictly biological problem, and also to indicate the nature of that problem, and some of the actual opportunities for investigating it. It is necessary to begin with a few words on the philosophical interpretation. We shall then describe the function of consciousness in animal life, and consider its part in the evolution of animals and of man. The views to be stated suggest certain practical recommendations, after presenting which I shall conclude by offering an hypothesis of the relation of consciousness to matter and force.

Consciousness is at once the oldest problem of philosophy and one of the youngest problems of science. The time is not yet for giving a satisfactory definition of consciousness, and we must fain content ourselves with the decision of the metaphysician, who postulates consciousness as an ultimate datum or concept of thought, making the brief dictum *cogito, ergo sum* the pivot about which his system revolves. I have endeavored vainly to discover by reading and by questioning those philosophers and psychologists whom I know, some deeper analysis of consciousness, if possible, resolving it into something more ultimate.

Opinions concerning consciousness are many and often so diverse as to be mutually exclusive, but they may be divided into two principal classes. The first class includes all those views which make of consciousness a real phenomenon; the second, those views which interpret it as an epiphenomenon. We are, I think practically all, agreed that the fundamental question is: Does or does not consciousness affect directly the course of events?—or, stated in other words, is consciousness a true cause? In short, we encounter at the outset the problem of free-will; of which more later.

The opinion that consciousness is an epiphenomenon has gained renewed prominence in recent times, for it is, so to speak, a collateral result of that great movement of European thought which has culminated in the development of the doctrine of monism. Monism itself is postulated chiefly upon the two greatest discoveries of the nineteenth century—the law of the conservation of energy, and the law of the evolution of species. Both laws establish a greater unity in the phenomena of the universe than mankind had previously been able to accept. In the physical world, instead of many forces, we now recognize only one force, which assumes various forms of energy; and in the living world we recognize one life, which manifests itself in many types of form. With these two unities in mind, what could be nearer than the thought that the unity goes still deeper, and that the phenomena of the inanimate or physical, and of the living world are fundamentally identical? The progress of physiological science has greatly increased the impetus towards the adoption of this thought as the cardinal dogma of the new faith, because the work of physiologists has been so devoted to the physical and chemical phenomena of life, that the conviction is widespread that all vital phenomena are capable of a physical explanation. Assuming that conviction to be correct, it is easy to draw the final conclusion that the physical explanation suffices for the entire universe. As to what is, or may

be, behind the physical explanation, complete agnosticism is of course the only possible attitude. Such in barest—but I believe correct—outline is the history of modern monism—the doctrine that there is but one kind of power in the universe.

It is evident that monism involves the elimination of two concepts, God and consciousness. It is true that monists sometimes use these words, but it is mere jugglery, for they deny the concept for which the words actually stand. Now consciousness is too familiar to all men to be summarily cast aside and dismissed. Some way must be found to account for it. From the monistic standpoint there is a choice between two possible alternatives; either consciousness is a form of energy, like heat, etc., or it is merely a so-called epiphenomenon. As there is no evidence that consciousness is a form of energy, only the second alternative is in reality available, and in fact has been adopted by the monists.

It is essential to have a clear notion of what is meant by an epiphenomenon. Etymologically the word indicates something which is superimposed upon the actual phenomenon. It designates an accompanying incident of a process which is assumed to have no causal relation to the further development of the process. In practice it is used chiefly in regard to the relation of the mind or consciousness to the body, and is commonly employed by those philosophers who believe that consciousness has no causal relation to any subsequent physiological process.

For many years I have tried to recognize some actual idea underneath the epiphenomenon hypothesis of consciousness, but it more and more seems clear to me that there is no idea at all, and that the hypothesis is an empty phrase, a subterfuge; which really amounts only to this—we can explain consciousness very easily by merely assuming that it does not require to be explained at all. Is not that really the confession made by the famous assertion that the consciousness of the brain no more requires explanation than the aquosity of water?

Monism is not a strong system of philosophy, for it is not so much the product of deep and original thinking as the result of a contemporary tendency. It is not the inevitable end of a logical process, because it omits consciousness, but rather an incidental result of an intellectual impulse. Its very popularity betokens its lack of profundity, and its delight in simple formulæ is characteristic of that mediocrity of thought which has much more ambition than real power and accepts simplicity of formularization as equivalent to evidence. It would seem stronger too, if it were less defended as a faith. Strong partizans make feeble philosophers.

Consciousness ought to be regarded as a biological phenomenon, which the biologist has to investigate in order to increase the number of verifiable data concerning it. In that way, rather than by speculative thought, is the problem of consciousness to be solved, and it is precisely because biologists are beginning to study consciousness that it is becoming, as I said in opening, the newest problem of science.

The biologist must necessarily become more and more the supreme arbiter of all science and philosophy, for human knowledge is itself a biological function which will become comprehensible just in the measure that biology progresses and brings knowledge of man, both by himself and through comparison with all other living things. We must look to biologists for the mighty generalizations to come rather than to the philosophers, because great new thoughts are generated more by the accumulation of observations than by deep

meditation. To know, observe. Observe more and more, and in the end you will know. A generalization is a mountain of observations; from the summit the outlook is broad. The great observer climbs to the outlook, while the mere thinker struggles to imagine it. The best that can be achieved by sheer thinking on the data of ordinary human experience we have already as our glorious inheritance. The principal contribution of science to human progress is the recognition of the value of accumulating data which are found outside of ordinary human experience.

Twenty-three years ago, at Saratoga, I presented before the meeting of this Association—which I then attended for the first time—a paper, 'On the Conditions to be Filled by a Theory of Life,' in which I maintained that, before we can form a theory of life, we must settle what are the phenomena to be explained by it. So now, in regard to consciousness it may be maintained that, for the present, it is more important to seek additional positive knowledge than to hunt for ultimate interpretations. We welcome therefore especially the younger science of experimental psychology, which, it is gratifying to note, has made a more auspicious start in America than in any other country. It completes the circle of the biological sciences. It is the department of biology to which properly belongs the problem of consciousness. The results of experimental psychology are still for the most part future. But I shall endeavor to show that we may obtain some valuable preliminary notions concerning consciousness from our present biological knowledge.

We must begin by accepting the direct evidence of our own consciousness as furnishing the basis. We must further accept the evidence that consciousness exists in other men essentially identical with the consciousness in each of us. The anatomical, physiological and psychological evidence of the identity of the phenomena in different human individuals is, to a scientific mind, absolutely conclusive, even though we continue to admit cheerfully that the epistemologist rightly asserts that no knowledge is absolute, and that the metaphysician rightly claims that *ego* is the only reality and everything else exists only as *ego's* idea, because in science as in practical life we assume that our knowledge is real and is objective in source.

For the purpose of the following discussion we must define certain qualities or characteristics of consciousness. The most striking distinction of the processes in living bodies, as compared with those in inanimate bodies, is that the living processes have an object—they are teleological. The distinction is so conspicuous that the biologists can very often say *why* a given structure exists, or *why* a given function is performed, but *how* the structure exists or *how* the function is performed he can tell very imperfectly, more often not at all. Consciousness is only a particular example; though an excellent one of this peculiarity of biological knowledge—we do not know what it is, we do not know how it functions, but we do know why it exists. Those who are baffled by the elusiveness of consciousness when we attempt to analyze it will do well to remember that all other vital phenomena are in the last instance equally and similarly elusive.

In order to determine the teleological value of consciousness, we must endeavor to make clear to ourselves what the essential function is which it performs. As I have found no description or statement of that function which satisfied me, I have ventured, perhaps rashly, to draw up the following new description:

The function of consciousness is to dislocate in time the reactions from sensations.

In one sense this may be called a definition of consciousness, but inasmuch as it does not tell what consciousness is, but only what it does, we have not a true definition, but a description of a function. The description itself calls for a brief explanation. We receive constantly numerous sensations, and in response to these we do many things. These doings are, comprehensively speaking, our reactions to our sensations. When the response to a stimulus is obviously direct and immediate we call the response a reflex action, but a very large share of our actions are not reflex but are determined in a far more complicated manner by the intervention of consciousness, which may do one of two things: (1) Stop a reaction, as, for example, when something occurs, calling, as it were, for our attention and we do not give our attention to it. This we call conscious inhibition. It plays a great rôle in our lives; but it does not mean necessarily that inhibited impressions may not survive in memory and at a later time determine the action taken; in such cases the potential reaction is stored up. (2) Consciousness may evoke a reaction from a remembered sensation and combine it with sensations received at other times. In other words, consciousness has a selective power, manifest both in choosing from sensations received at the same time and in combining sensations received at different times. It can make synchronous impressions dyschronous in their effects, and dyschronous impressions synchronous. But this somewhat formidable sentence merely paraphrases our original description: The function of consciousness is to dislocate in time the reactions from sensations.

This disarrangement and constant rearrangement of the sensations, or impressions from sensations, which we gather, so that their connections in time are altered seems to me the most fundamental and essential characteristic of consciousness which we know. It is not improbable that hereafter it will become possible to give a better characterization of consciousness. In that case the opinion just given may become unsatisfactory, and have to yield to one based on greater knowledge. The characteristic we are considering is certainly important, and so far as the available evidence goes it belongs exclusively to consciousness. Without it life would have no interest, for there would be no possibility of experience, no possibility of education.

Now the more we have learned about animals, the better have we appreciated the fact that in them only such structures and functions are preserved as are useful, or have a teleological value. Formerly a good many organs were called rudimentary or vestigial and supposed to be useless survivals because they had no known function. But in many cases the functions have since been discovered. Such, for example, were the pineal gland, the pituitary body, the suprarenal capsules and the Wolffian body of man, all of which are now recognized to be functionally important structures. Useless structures are so rare that one questions whether any exist at all, except on an almost insignificant scale. It has accordingly become well-nigh impossible for us to imagine consciousness to have been evolved, as it has been, unless it had been bionomically useful. Let us therefore next consider the value of consciousness from the standpoint of bionomics.*

We must begin with a consideration of the nature of sensations and the object of the reactions which they cause. In the simpler forms of nervous action a force, usually but not necessarily external to the organism, acts as a stimulus which causes

* A convenient term, recently gaining favor, for what might otherwise be called the economics of the living organism. Bionomics seems preferable to *ecology*, which some writers are adopting from the German.

an irritation; the irritation produces a reaction. Within the ordinary range of the stimuli to which an organism is subjected, the reaction is teleological, that is, it tends to the benefit of the organism. A familiar illustration is the presence of food in the stomach, which produces a stimulus, the reaction to which is manifested by the secretion of the digestive fluid for the purpose of digesting the food. An organism might conceivably be maintained solely by this mechanism in cooperation with the physical laws which govern all matter. Life in such an organism would be a succession of teleological processes, essentially mechanical and regulated automatically by the organism. By far the majority of biologists regard plants as essentially conforming to this type of life. Whether they absolutely so conform we do not, of course, yet know.

A sensation involves the interpolation of consciousness between the stimulation and the reaction, and in consequence there is established the possibility of a higher order of adjustment to the external world than can be attained through the teleological reaction to a stimulus. This possibility depends upon the fact that the intervention of consciousness permits an adjustment in accordance not merely with the immediate sensation, but also, and at the same time, in accordance with earlier sensations. Thus, for example, the child sees an object, and its reaction is to take hold of the object, which is hot and hurts the child. Later the child sees the object again and its natural reaction is to take hold of it again, but the child now reacts differently because its consciousness utilizes the earlier as well as the present sensation; the previous sensation is dislocated in time and fused with the present sensation and a new reaction follows. No argument is necessary to establish the obvious conclusion that an organism which has consciousness has an immensely increased scope for its adjustments to the external conditions; in other words consciousness has a very high value for the organism. It is unnecessary to dwell upon this conclusion, for it will be admitted by every one, except perhaps those who start with the *a priori* conviction that consciousness is an epiphenomenon.

A sensation gives information concerning the external world. Perhaps science has achieved nothing else which has done so much to clarify philosophy as the demonstration that the objective phenomena are wholly unlike the subjective sensations. Light is a series of undulations, but we do not perceive the undulation as such, but as red, yellow and green, or as we say colors; the colors give us available information, and we use them as so many labels, and we learn that reactions to these labels may be helpful or hurtful, and so we regulate our conduct. Objectively red, yellow and green do not exist. Similarly with the vibrations of the air, certain of which cause the sensation of sound, which is purely subjective. But the sound gives us information concerning our surroundings, which we utilize for our teleological needs, although in nature external to us there is no sound at all. Similarly all our other senses report to us circumstances and conditions, but always the report is unlike the external reality. Our sensations are symbols merely, not images. They are, however, bionomically sufficient because they are constant. They are useful not because they copy the external reality or represent it, but because, being constant results of external causes, they enable consciousness to prophesy or foresee the results of the reactions of the organism, and to maintain and improve the continual adjustment to the external reality.

The metaphysicians have for centuries debated whether there is any external objective reality. Is it too much to say that the biological study of consciousness settles

the debate in favor of the view that the objective world is real?

Consciousness is not only screened from the objective world from which it receives all its sensations, but also equally from immediate knowledge of the body through which it acts. As I write this sentence I utilize vaso-motor nerves, regulating the cerebral blood currents, and other nerves which make my hand muscles contract and relax, but of all this physiological work my consciousness knows nothing though it commands the work to be done. The contents of consciousness are as unlike what is borne out from it as they are unlike what is borne in to it.

The peculiar untruthfulness to the objective which consciousness exhibits in what it gets and gives would be perplexing were it not that we have learned to recognize in consciousness a device to secure better adjustment to external reality. For this service the system of symbols is successful, and we have no ground for supposing that the service would be better if consciousness possessed direct images or copies instead of symbols of the objective world.

Our sensory and motor* organs are the servants of consciousness; its messengers or scouts; its agents or laborers; and the nervous system is its administrative office. A large part of our anatomical characteristics exist for the purpose of increasing the resources of consciousness, so that it may do its bionomic function with greater efficiency. Our eyes, ears, taste, etc., are valuable, because they supply consciousness with data; our nerves, muscles, bones, etc., are valuable, because they enable consciousness to effect the needed reactions.

Let us now turn our attention to the problem of consciousness in animals. The comparative method has an importance in biology which it has in no other science, for life exists in many forms which we commonly call species. Species, as I once heard it stated, differ from one another with resemblance. The difference which resembles we term an homology. Our arm, the bird's wing, the lizard's front leg are homologous. The conception of homology both of structure and of function lies at the basis of all biological science, which must be and remain incomprehensible to any mind not thoroughly imbued with this conception. Only those who are deficient in this respect can fail to understand that the evidence is overwhelming that animals have a consciousness homologous with the human consciousness. The proof is conclusive. As regards at least mammals—I think we could safely say as regards vertebrates—the proof is the whole sum of our knowledge of the structure, functions and life of these animals.

As we descend the animal scale to lower forms there is no break and therefore no point in the descent where we can say here animal consciousness ends, and animals below are without it. It seems inevitable therefore to admit that consciousness extends far down through the animal kingdom, certainly at least as far down as there are animals with sense organs or even the most rudimentary nervous system. It is unsatisfactory to rely chiefly on the anatomical evidence for the answer to our query. We await eagerly results from psychological experiments on the lower invertebrates. A sense organ however implies consciousness, and since such organs occur among cœlenterates we are led to assign consciousness to these animals.

The series of considerations which we have had before us lead directly to the conclusion that the development and improvement of consciousness has been the most important, really the dominant, factor in the evolution of the animal series. The

* And other organs in efferent relations to consciousness.

sense organs have been multiplied and perfected in order to supply consciousness with a richer, more varied and more trustworthy store of symbols corresponding to external conditions. The nervous system has grown vastly in complexity in order to permit a constantly increasing variety in the time dislocations of sensation. The motor and allied apparatus have been multiplied and perfected in order to supply consciousness with more possibilities of adjustment to external reality which might be advantageous.

If we thus assign to consciousness the leading rôle in animal evolution we must supplement our hypothesis by another, namely, that conscious actions are primary; reflex and instinctive actions secondary, or, in other words, that, for the benefit of the organism, conscious actions have been transformed into reflexes and instincts. Unfortunately we must rely chiefly on future physiological and psychological experiments to determine the truth of this hypothesis. Its verification, however, is suggested by certain facts in the comparative physiology of the vertebrate nervous system, which tend to show that in the lower forms (amphibia) a certain degree of consciousness presides over the functions of the spinal cord, which in mammals is devoted to reflex actions. Its verification is further suggested by the natural history of habits. As we all know, new actions are performed with difficulty and slowly, but if often repeated they are soon easier and more rapid. If a given reaction to a sensation or group of sensations through consciousness is advantageous to the organism and the environment is such that the sensation is often repeated, then a habit is formed and the response becomes more rapid, and often in ourselves we see habits which arose from conscious action working almost without the participation of consciousness, and moreover working usefully because rapidly. The usefulness of conscious reactions is that they are determined not merely by the present sensation but also by past sensations, but they have the defect that they are slow. We can readily understand that it would aid an organism to have the quicker reaction substituted, and we thus recognize a valid teleological reason for the replacement of conscious action by habits in the individual, by instincts in the race. The investigation of the evolution of reflexes and instincts is one of the important and most promising tasks of comparative psychology.

A frank unbiased study of consciousness must convince every biologist that it is one of the fundamental phenomena of at least animal life, if not, as is quite possible, of all life. Nevertheless its consideration has barely a place in biological science, although it has long occupied a vast place in philosophy and metaphysics. If this address shall contribute to a clearer appreciation of the necessity of treating consciousness as primarily a problem for biological research to solve, my purpose will be achieved. In an ideal world philosophers and scientists would be identical; in the actual world there are philosophical scientists and scientific philosophers, but in the main the followers of the two disciplines pursue paths which are unfortunately distinct. The philosophical mind is of a type unlike the scientific. The former tries to progress primarily by thought based on the data available, the latter seeks to advance primarily by collecting additional data. The consequence of this difference is that philosophy is dependent upon the progress of science, but we who pursue the scientific way make no greater mistake than to underestimate philosophy. The warning is needed. Data of observation are a treasure and very precious. They are the foundation of our mental wealth, but that wealth consists of the

thought into which the data are transmitted. In pleading therefore for an increased observational study of consciousness we plead, not merely for science, but equally for philosophy. The scientific progress must come first. Hence we urge the advantage of investigating consciousness in its immediate revelations which are accessible now. Let us give up the ineffectual struggle to discover the essential nature of consciousness until we can renew it with much larger resources of knowledge.

The psychologists ought now to apply the comparative method on a grand scale. They are just beginning to use it. Years of patient labor must pass by, but the reward will be very great. The psychic life of animals must be minutely observed, the conditions of observation carefully regulated and the results recorded item by item. The time has passed by for making generalizations on the basis of our common, vague and often inexact notions concerning the habits of animals. Exact experimental evidence will furnish a rich crop of psychological discovery. Scientific psychology is the most backward in its development of all the great divisions of biology. It needs, however, little courage to prophesy that it will bring forth results of momentous importance to mankind. After data have been gathered, generalization will follow which, it may be hoped, will lead us on to the understanding of even consciousness itself.

The teleological impress is stamped on all life. Vital functions have a purpose. The purpose is always the maintenance of the individual or of the race in its environment. The entire evolution of plants and animals is essentially the evolution of the means of adjustment of the organism to external conditions. According to the views I have laid before you, consciousness is a conspicuous, a commanding, factor of adjustment in animals. Its superiority is so great that it has been, so to speak, eagerly seized upon by natural selection and provided with constantly improved instruments to work with. A concrete illustration will render the conception clearer. In the lowest animals, the cœlenterates, in which we can recognize sense organs, the structure of them is very simple, and they serve as organs of touch and of chemical sensation resembling taste. In certain jelly fishes we find added special organs of orientation and pigmented spots for the perception of light. In worms we have true eyes and vision. In vertebrates we encounter true sense of smell. Fishes cannot hear, but in the higher vertebrates, that is from the amphibians up, there are true auditory organs. In short, both the senses once evolved are improved and also new senses are added. It is perfectly conceivable that there should be yet other senses, radically different from any we know. Another illustration, and equally forcible, of the evolution of aids to consciousness might be drawn from the comparative history of the motor systems, passing from the simple contractile thread to the striated muscle fiber, from the primitive diffuse musculature of a hydroid to the highly specialized and correlated muscles of a mammal.

It is interesting to consider the evolution of adjustment to external reality in its broadest features. In the lowest animals the range of the possible adjustment is very limited. In them not only is the variety of possible actions small, but they cover also a small period of time. In animals which have acquired a higher organization the adjustments are more complex, both because the reactions are more varied and because they cover a longer period of time. Thus the jelly fish depends upon such food as happens to come within its reach, seizing from moment to

moment that which it encounters; but a lobster pursues its food, making complicated movements in order to reach and seize it. One can trap lobsters easily; I doubt if one could trap a jelly fish at all. The next great advance is marked by the establishment of communication between individuals of the same species. About this phenomenon we know exceedingly little; the investigation of it is one of the most important duties of the comparative physiologist. Its bionomic value is obviously great, for it allows an individual to utilize the experience of another as well as its own. We might, indeed, compare it with the addition of a new sense, so greatly does it extend the sources of information. The communication between individuals is especially characteristic of vertebrates, and in the higher members of that subkingdom it plays a very great rôle in aiding the work of consciousness. In man, owing to articulate speech, the factor of communication has acquired a maximum importance. The value of language, our principal medium of communication, lies in its aiding the adjustment of the individual and the race to external reality. Human evolution is the continuation of animal evolution, and in both the dominant factor has been the increase of the resources available for consciousness.

In practical life it is convenient to distinguish the works of nature from the works of man, the 'natural' from the 'artificial.' The biologist, on the contrary, must never allow himself to forget that man is a part of nature and that all his works are natural works. This is specially important for the present discussion, for otherwise we are likely to forget also that man is as completely subject to the necessity of adjustment to external reality as any other organism. From the biological standpoint all the work of agriculture, of manufactures, of commerce and of government is a part of the work of consciousness to secure the needed adjustments. All science belongs in the same category as the teleological efforts of a jelly fish or a lobster. It is work done at the command of consciousness to satisfy the needs of existence. The lesson of all this to us is that we should accustom ourselves to profit by our understanding of the trend of evolution, which, in the progress humanity makes, obeys the same law of adaptation to objective reality which has controlled the history of animals. This view of the conditions of our existence puts science in its right place. As all sensations are symbols of external reality useful to guide organisms to teleological reactions, so is all science symbolic and similarly useful.

Nature never produces what to us seems a perfect organism, but only organisms which are provided with means of adjustment sufficient to accomplish the survival and perpetuation of the species. Man also is imperfect, but in the struggle for existence wins his way because his consciousness has greater resources than that of any other organism. His great power arises from his appreciation of evolution. His highest duty is to advance evolution, and this duty must be most strongly felt by those who accept the religious interpretation of life. The advancement of science is an obligation. To this view of the work of our Association I may safely claim the assent of all present.

The function of science is to extend our acquaintance with the objective world. The purpose of the American Association is not alone to increase the sum total of science, but equally also to preach by word and precept the value of truth, truth being the correct conscious symbol of the objective, by utilizing which our purposeful reactions are improved. The most serious obstacle truth encounters is the prevalence of what I may call 'doll ideas'—by anal-

ogy with the material dolls, with which children play. The child makes believe with the doll, knowing all the time its unreality, assigns to it hopes, passions, appetites; the child may feel the intensest sympathy with its doll, weep at its sorrows, laugh over its joys, yet know always that it is a mere inanimate, senseless doll. Adult men and women have ideas, with which they play make-believe; doll ideas, which they know are unreal, and yet they mourn sincerely over the adversities of their mental dolls, rejoice over their successes and fight for them with passion. Such doll ideas become mingled with the real and inextricably woven into the fabric of life. They are treated with the most earnest seriousness. Men will fight for them as a child will fight for its doll, not because it is property, but because it is a sacred personality. So are doll ideas often made sacred and defended with fanaticism. Yet, behind, in consciousness is the sense of unreality, the disregarded admission of 'making believe.' Do not doll ideas, pseudo-opinions, play a great rôle in human life? I think they do, and thinking so, deem it all the more imperative that you and others should teach the people the standard of science, the humble acknowledgment of reality. I wish that an impulse toward this goal from our Association could be imparted to every man and woman in the country, and I hope that the Association may continue to grow in number and power for long years to come, as it has grown in the last few years, so that it shall be a national, all-pervading influence serving the truth.

It seems to me inconceivable that the evolution of animals should have taken place as it actually has taken place, unless consciousness is a real factor and dominant. Accordingly I hold that it actually affects the vital processes. There is, in my opinion, no possibility of avoiding the conclusion that consciousness stands in immediate causal relations with physiological processes. To say this is to abide by the facts, as at present known to us, and with the facts our conceptions must be made to accord.

The thought which I wish to emphasize is the importance for the future investigation of consciousness of separating the study of what it does from the study of what it is. The latter study is recondite, metaphysical, and carries us far beyond the limits of verifiable human knowledge. The former study is open to us and offers opportunities to science, but it has hitherto been almost completely neglected. Biology has now to redeem itself by effectual researches on consciousness. On the adequate prosecution of such researches we base great hopes.

Before I close permit me a few words concerning the relations of consciousness to the body, to living substances through which it manifests itself. It is intimately linked to protoplasm. Probably no question is so profoundly interesting to all mankind as the old question, what is the relation of the mind to the body? It is a question which has been stated in many forms and from many points of view, but the essential object of the question is always the same, to ask whether consciousness is a function of living matter, or something discrete and not physical or material.

Throughout this address consciousness has been viewed as a device to regulate the actions of the organisms so as to accomplish purposes which on the whole are useful to the organisms, and accordingly we have termed its function teleological. If this view is correct it accounts for the limitations of consciousness, its mechanical mode of work, its precision and definiteness of action, for of course, unless consciousness is orderly and obeys laws, it cannot be of use to the organism, but, on

the contrary, it would be harmful, and conscious animals would have ceased long ago to survive. The very fact that consciousness is of such high value in the bionomy of an animal renders it obvious that it must be subject to law. Accordingly it appears to us regulated as do the functions of protoplasm. Hence to certain modern thinkers it presents itself as a function of protoplasm, or, as it may be better stated, as a state or condition of protoplasm.

The internal evidence of consciousness, however, is against this view and presents to us conscious actions as depending upon the consciousness. As before stated I believe that this evidence must be accepted. Now all the sensations of consciousness are derived from physical force, and all the acts of consciousness are manifested through physical force; hence if it has any real power consciousness must be able to change the form of energy. Unless we accept this doctrine, we must give up all belief in free-will and adopt the automaton theory of life. Is not the more reasonable explanation that which is based upon all the contents of our consciousness rather than that which we can draw by discarding the internal evidence which consciousness brings us? The hypothesis which I offer for your consideration is this:

Consciousness has the power to change the form of energy, and is neither a form of energy nor a state of protoplasm.

By this hypothesis there are two fundamentally different things in the universe, force and consciousness. You ask why I do not say three, and add matter? My answer is that we do not have, and never have had, any evidence whatever that matter exists. All our sensations are caused by force and by force only, so that the biologist can say that our senses bring no evidence of matter. The concept 'matter' is an irrational transfer of notions derived from the gross molar world of the senses to the molecular world. Faraday long ago pointed out that nothing was gained and much lost by the hypothesis of material atoms, and his position seems to me impregnable. It would be a great contribution to science to kill off the hypothesis of matter as distinct from force.

To conclude: The universe consists of force and consciousness. As consciousness by our hypothesis can initiate the change of the form of energy, it may be that without consciousness the universe would come to absolute rest. Since I close with a bold speculation let my last words recall to you that my text is: Investigate consciousness by comparative observations. Only from observation can we know. Correct, intelligent, exhaustive observation is our goal. When we reach it human science will be completed.

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*RECENT PROGRESS IN AMERICAN BRIDGE CONSTRUCTION.**

IN view of the great achievements in engineering construction which characterized the latter part of the nineteenth century in America, it seems appropriate to give a brief review of the most recent progress in one of its departments, that of bridge construction. It appears to be the more fitting since the place of this meeting of the Association is the greatest center of production of the material which constitutes the bulk of that used for modern bridges.

The application of scientific principles to the construction of bridges is more complete to-day than ever before. This statement applies to the specified requirements

* Address of the Vice-president and Chairman of Section D—Mechanical Science and Engineering—of the American Association for the Advancement of Science, Pittsburgh Meeting, June 28–July 3, 1902.

which the finished structure must fulfill, the design of every detail to carry the stresses due to the various loads imposed, the manufacture of the material composing the bridge, the construction of every member in it, and finally the erection of the bridge in the place where it is to do its duty as an instrument of transportation.

A close study of the economic problems of transportation in the United States and the experimental application of its results led the railroad managers to the definite conviction that, in order to increase the net earnings while the freight rates were slowly but steadily moving downward, it was necessary to change the method of loading by using larger cars drawn by heavier locomotives, so as to reduce the cost of transportation per train mile. While these studies had been in progress for a number of years and there was a gradual increase in the weight of locomotives, it is only within the past five years that the test was made, under favorable conditions and on an adequate scale, to demonstrate the value of a decided advance in the capacity of freight cars and in the weight of locomotives for the transportation of through freight. The test was made on the Pittsburgh, Bessemer and Lake Erie Railroad, which was built and equipped for the transportation of iron ore from Lake Erie to Pittsburgh and of coal in the opposite direction.

When this economic proposition was fairly established, it was wonderful to see how railroad managers and capitalists met the situation, by investing additional capital for the newer type of equipment, and for the changes in road bed and location necessarily involved by that in the rolling stock. Curves were taken out or diminished, grades were reduced, heavier rails were laid, and new bridges built, so that practically some lines were almost rebuilt. The process is still going on and money by the hundred millions is involved in the transformation and equipment of the railroads. Some impression of the magnitude of the change in equipment may be gained from the single fact, that one of the leading railroads has within a few years expended more than twenty millions of dollars for new freight cars alone, all of which have a capacity of 100,000 pounds. The form of loading for bridges almost universally specified by the railroads of this country consists of two consolidation locomotives followed by a uniform train load. These loads are frequently chosen somewhat larger than those that are likely to be actually used for some years in advance, but sometimes the heaviest type of locomotives in use is adopted as the standard loading. The extent to which the specified loadings have changed in eight years may be seen from the following statement based on statistics compiled by Ward Baldwin and published in the *Railroad Gazette* for May 2, 1902.

Of the railroads whose lengths exceed 100 miles, located in the United States, Canada and Mexico, only 2 out of 77 specified uniform train loads *exceeding* 4,000 pounds per linear foot of track in 1893, while in 1901, only 13 out of 103 railroads specified similar loads *less* than 4,000 pounds. In 1893, 37 railroads specified loads of 3,000 pounds and 29 of 4,000 pounds, while in 1901, 4,000 pounds was specified by 50, 4,500 pounds by 14, and 5,000 pounds by 17 railroads. The maximum uniform load rose from 4,200 in 1893 to 6,600 pounds in 1901.

In a similar manner in 1893 only 1 railroad in 75 specified a load on each driving wheel axle *exceeding* 40,000 pounds, while in 1901 only 13 railroads out of 92 specified *less* than this load. In 1893 only 21 of the 77 railroads specified similar loads exceeding 30,000 pounds. The maximum load on each driving wheel axle rose from

44,000 pounds in 1893 to 60,000 pounds in 1901.

The unusual amount of new bridge construction required caused a general revision of the standard specifications for bridges, the effect of which was to include the results of recent studies and experiment, and to eliminate some of the minor and unessential items formerly prescribed.

Meanwhile another movement was in progress. Experience having shown the great advantage of more uniformity in various details and standards relating to the manufacture of bridges both in reducing the cost and the time required for the shop work, an effort was begun to secure more uniformity in the requirements for the production and tests of steel, which is the metal now exclusively employed in bridges.

The American Section of the International Association of Testing Materials is bringing together through its investigations and discussions a mass of selected information on the relations of chemical composition, heat treatment, mechanical work, etc., to the physical properties of steel as well as of other metals used in structures and for mechanical purposes.

The thorough digest of these results of scientific research and practical tests, and the preparation and adoption of standard specifications for different classes of material, are confidently expected to eliminate many old requirements which are proved inefficient in securing the results for which they were originally intended, and to incorporate in the specifications only the essential requirements by which the character of the product may be determined with sufficient precision for its actual duty. By making these requirements reasonable and fair, on the one hand as simple and definite as possible without impairing their real value, and on the other hand flexible enough to avoid imposing undue hardship upon the manufacturer who keeps in touch with the best methods available, the result is confidently expected to be a high degree of interested cooperation on the part of both engineer and manufacturer in securing the best grade of material which the present state of science makes practicable.

The American section of that Association in 1901 adopted a series of proposed standard specifications, one of which relates to steel for bridges and buildings and which is recommended for adoption by those who buy such structures. A committee of the Railway Engineering and Maintenance of Way Association is now at work on the same problem, a full agreement having not yet been reached.

With greater uniformity in the physical, chemical and other requirements for steel, as determined by standard tests, the unit stresses to be prescribed for the design of bridges will naturally approach to a corresponding uniformity. To what extent this is desirable may be inferred from the fact that the application of several of the leading specifications to the design of a railroad bridge under a given live load yields results which may vary by an amount ranging from zero to twenty-five per cent. of the total weight.

In the revision of specifications a decided tendency is observed to simplify the design by making an allowance for impact, vibration, etc., by adding certain percentages to the live load according to some well-defined system. It needs but relatively little experience in making comparative designs of bridges under the same loading, to show the advantage of this method over that in which the allowance is made in the unit stresses according to any of the systems usually adopted in such a case. Not only are the necessary computations greatly simplified but the same degree of

security is obtained in every detail of the connections as in the principal members which compose the structure.

Experiments on a large scale are very much needed to determine the proper percentage of the live load to be allowed for the effect of impact, so as to secure the necessary strength with the least sacrifice of true economy. While the extreme economy of material that was formerly practised is not now desirable, since stiffness receives due consideration, some idea of the importance of such an investigation may be gained by considering the magnitude of the industries involved.

In March, the *Railroad Gazette* published a supplement containing a list of bridge projects under consideration. This list was intended to include only the larger steel and stone structures, whether for railroads or highways, the aim being to exclude those that are obviously unimportant. Besides this, the bridges needed on 1,500 new railroad projects recorded in the same supplement are likewise excluded. After excluding both of these classes the list still contains about 1,300 new projects for bridges.

An investigation might also be advantageously made to determine the proper ratio of the thickness of cover plates in chord members which are subject to compression, to the transverse distance between the connecting lines of rivets. The same need exists in regard to the stiffening of the webs of plate girders, concerning which there is a wide variation in the requirements of different specifications.

A movement which has done much good during the past decade and promises more for the future is that of the organization of bridge departments by the railroad companies. The great economy of making one design rather than to ask a number of bridge companies to make an equal number of designs, of which all but one are wasted, is the first advantage; but another of even greater significance in the development of bridge construction is that which arises from the designs being made by those who observe the bridges in the conditions of service and who will naturally devote closer study to every detail than is possible under the former usual conditions. The larger number of responsible designers also leads to the introduction of more new details to be submitted to the test of service, which will indicate those worthy of adoption in later designs. In order to save time and labor and secure greater uniformity in the design of the smaller bridges, some of the railroads prepare standard plans for spans varying by small distances. For the most important structures consulting bridge engineers are more frequently employed than formerly, when so much dependence was placed upon competitive designs made by the bridge companies.

An investigation was recently made by a committee of the Railway Engineering and Maintenance of Way Association in regard to the present practice respecting the degree of completeness of the plans and specifications furnished by the railroads. It was found that of the 72 railroads replying definitely to the inquiry, 33 per cent. prepare 'plans of more or less detail, but sufficiently full and precise to allow the bidder to figure the weight correctly and if awarded the contract to at once list the mill orders for material'; 18 per cent. prepare 'general outline drawings showing the composition of members, but no details of joints and connections'; while 49 per cent. prepare 'full specifications with survey plan only, leaving the bidder to submit a design with his bid.' If, however, the comparison be made on the basis of mileage represented by these 72 railroads, the corresponding percentages are 48, 24 and 28 respectively. The total mile-

age represented was 117,245 miles. A large majority of the engineers and bridge companies that responded were in favor of making detail plans.

The shop drawings, which show the form of the bridge, the character and relations of all its parts, give the section and length of every member, and the size and position of every detail whether it be a reinforcing plate, a pin, a bolt, a rivet or a lacing bar. All dimensions on the drawings are checked independently so as to avoid any chance for errors. The systematic manner in which the drawings are made and checked, and the thorough organization of every department of the shops, makes it possible to manufacture the largest bridge, to ship the pieces to a distant site and find on erecting the structure in place that all the parts fit together, although they had not been assembled at the works.

The constant improvement in the equipment of the bridge shops, and the increasing experience of the manufacturers who devote their entire time and attention to the study of better methods for transforming plates, bars, shapes, rivets and pins into bridges, constitute important factors in the development of bridge construction.

As the length of span for the different classes of bridges gives a general indication of the progress in the science and art of bridge building, the following references are made to the longest existing span for each class, together with the increase in span which has been effected approximately during the past decade.

In plate girder bridges the girders, as their name implies, have solid webs composed of steel plates. A dozen years ago but few plate girders were built whose span exceeded 100 feet, the maximum span being but a few feet longer than this. To-day such large girders are very frequently constructed, and the maximum span has been increased to 126 feet between centers of bearings. This is the span of the large plate girders of the viaduct on the Riverside drive in New York City, erected in 1900. The longest railroad plate girder was erected about the same time on the Bradford Division of the Erie Railroad, its span being 125 feet 2½ inches. The heaviest plate girder is the middle one of a four-track bridge on the New York Central Railroad erected last year near Lyons, N. Y. Its weight is 103 tons, its span 107 feet 8 inches, and its depth out to out 12 feet 2 inches.

The large amount of new construction and the corresponding increase in the weight of the rolling stock have combined to secure a more extensive adoption of plate girders and the designs of many new details for them. These affect chiefly the composition of the flanges, the web splices, the expansion bearings and the solid floor system. Although solid metal floors built up of special shapes were first introduced into this country fifteen years ago, their general adoption has taken place largely within the past decade on account of their special adaptation to the requirements of the elevation of tracks in cities. Solid floors may not only be made much shallower than the ordinary open type, thereby reducing the total cost of the track elevation, but they also permit the ordinary track construction with cross-ties in ballast to be extended across the bridge, thus avoiding the jar which otherwise results as the train enters and leaves the bridge, unless the track is maintained with extraordinary care.

The necessity for bridges of greater stiffness under the increased live loads has also led to the use of riveted bridges for considerably longer spans than were in use six or seven years ago. The use of pin-connected trusses for spans less than about 150 feet is undesirable for railroad bridges, on account of the excessive vibration due to

the large ratio of the moving load to the dead load, or weight of the bridge itself.

While riveted bridges are now quite generally used for spans from 100 to 150 feet, they have been employed to some extent up to 181½ feet. The recent forms of riveted trusses do not, however, conform to the general character of European designs but embody the distinctively American feature of concentrating the material into fewer members of substantial construction. With but rare exceptions the trusses are of the Warren, Pratt and Baltimore types with single systems of webbing. At a distance where the riveted connections cannot be distinguished, the larger trusses have the same general appearance as the corresponding pin bridges.

The recent examples of viaduct construction with their stiff bracing of built-up members and riveted connections exhibit a marked contrast to the older and lighter structures with their adjustable bracing composed of slender rods. The viaduct which carries the Chicago and Northwestern Railroad across the valley of the Des Moines River, at a height of 185 feet above the surface of the river is 2,658 feet long. It was built in 1901, is the longest double-track viaduct in the world, provided those located in cities be excluded, and is an admirable type of the best modern construction. The tower spans are 45 feet long and the other spans are 75 feet long. Four lines of plate girders support the two tracks. Along with this viaduct should be mentioned the Viaduct Terminal of the Chesapeake and Ohio Railway at Richmond, Va., whose length including the depot branch is 3.13 miles. A large part of this is not very much higher than an elevated railroad in cities. The excellent details and clean lines of this substantial structure give it a character which is surpassed neither in this country nor abroad. It may be added that the highest viaduct in this country, and which was rebuilt in 1900, is located seventeen miles from Bradford, Pa., where the Erie Railroad crosses the Kinzua Creek at a height of 301 feet. It has a length of 2,053 feet.

While the elevated railroads which have been built recently, also embody many of the characteristics of the best viaduct construction, special study has been given to improve their esthetic effect. The use of curved brackets, of connecting plates whose edges are trimmed into curves so as to reduce the number of sharp angles, and of rounded corners of posts, constitute some of the means employed. The results are seen in the structures of the Boston Elevated Railroad and in some of the latest construction in Chicago.

The longest span of any simple truss in America is that of the bridge over the Ohio River at Louisville, erected in 1893. Its span center to center of end pins is 546½ feet. Since that time several other bridges of this kind have been built which are considerably heavier, although their spans are somewhat shorter. The most noteworthy of these are the Delaware River bridge on the Pennsylvania Railroad near Philadelphia and the Monongahela River bridge of the Union Railroad at Rankin, Pa., both of which are double-track bridges. The Delaware River bridge was erected in 1896, each one of its fixed spans having a length of 533 feet and containing 2,094 tons of steel. The Rankin bridge was erected in 1900. Its longer span has a length of 495 feet 8⅜ inches between centers of end pins and contains about 2,800 tons of steel, making it the heaviest single span ever erected. It may also be added that the locomotive and train load for which this bridge was designed is the heaviest that has yet been specified.

The recent changes in the details of pin-connected truss bridges have been mainly

the result of efforts to eliminate ambiguity in the stresses of the trusses, to reduce the effect of secondary stresses, and to secure increased stiffness as well as strength in the structure. Double systems of webbing have been practically abandoned so far as new construction is concerned. The simplicity of truss action thus secured permits the stresses to be computed with greater accuracy and thereby tends to economy. Before the last decade very few through bridges and those only of large span were designed with end floor beams in order to make the superstructure as complete as possible in itself and independent of the masonry supports. Now this improved feature is being extended to bridges of small spans. Similarly dropping the ends of all floor beams in through bridges so as to clear the lower chord and to enable the lower lateral system to be connected without producing an excessive bending movement in the posts has likewise been extended to the smaller spans of pin bridges and is now the standard practice. The expansion bearings have been made more effective by the use of larger rollers, and of bed plates so designed as to properly distribute the large loads upon the masonry. In the large spans of through bridges the top chord is curved more uniformly, thereby improving the esthetic appearance. These chords are also given full pin bearings, thus reducing the secondary stresses.

The stiffness of truss bridges has been secured by adopting stiff bracing in the lateral systems and sway bracing, instead of the light adjustable rods formerly used. At the same time adjustable counter ties in the trusses are being replaced in recent years by stiff ones, while in some cases the counters are omitted and the main diagonals designed to take both tension and compression.

Some of the same influences referred to above have led to much simpler designs for the portal bracing by using a few members of adequate strength and stiffness similar in general character to those of the trusses.

Such steady progress in the design and construction of railroad bridges of moderate span has, unfortunately, no adequate counterpart in highway bridges. The conditions under which highway bridges are purchased by township and county commissioners are decidedly unfavorable to material improvements in the character of their details. It is a comparatively rare occurrence that the commissioners employ a bridge engineer to look after the interests of the taxpayers by providing suitable specifications, making the design, inspecting the material, and examining the construction of the bridge to see that it conforms to all the imposed requirements. These provisions are only made in some of the cities, and accordingly one must examine the new bridges in cities to learn what progress is making in highway bridge building.

The lack of proper supervision in the rural districts and many of the smaller cities results in the continued use of short trusses with slender members built up of thin plates and shapes, whose comparatively light weight causes excessive vibration and consequent wear, as well as deterioration from rust. Under better administration plate girders would be substituted for such light trusses, making both a stiffer structure and one more easily protected by paint. The general lack of inspection and the consequent failure to protect highway bridges by regular repainting will materially shorten their life and thereby increase the financial burden to replace them by new structures. Some progress has been made in adopting riveted trusses for the shorter spans for which pin-connected trusses were formerly used, but the extent of this change is by no means as extensive as it should be, nor equal to the corresponding advance in railroad bridges.

The channel span of the cantilever bridge over the Mississippi River at Memphis, Tenn., is the longest one of any bridge of this class in America. It measures 790½ feet between centers of supports. This bridge was finished in 1890, the same year that marked the close of the seven-year period of construction and erection of the mammoth cantilever bridge over the Firth of Forth in Scotland. A number of cantilever bridges have been built since then, but most of them have comparatively short spans. There is one now under construction over the Monongahela River in Pittsburgh, and which is expected to be finished this year, whose span is to be a little longer than that of the Memphis bridge. It is on the new extension of the Wabash Railroad system, and the distance between pier centers is 812 feet.

But there is another one being built which will not only have a longer span than any other cantilever bridge in this country, but longer than that of any other bridge whatsoever. It is located near Quebec, Canada, and its channel span over the Saint Lawrence River is to have the unprecedented length of 1,800 feet or nearly a hundred feet longer than that of the Forth cantilever bridge and two hundred feet longer than the Brooklyn suspension bridge. The towers will have a height of 360 feet above high tide. It will accommodate a double-track railroad, besides two electric railway tracks and highways. In the piers the courses of masonry are four feet high and individual stones weigh about fifteen tons each. The character of its design and the simplicity of its details will permit its construction with unusual rapidity and economy for a bridge of this magnitude. Several other cantilever structures whose largest spans range from 600 to 671 feet are either now or soon will be under construction.

The Brooklyn bridge, completed in 1883, is still the largest suspension bridge in the world, its span being 1,595½ feet. More people cross this bridge than any other in any country. The New East River bridge, which is now being built, has a span of 1,600 feet, and its capacity will be very much greater than that of the Brooklyn bridge. Each of its four cables has a safe strength of over 10,000,000 pounds in tension.

One of the most interesting developments relating to the subject under consideration is the construction of a considerable number of metallic arch bridges in recent years and the promise of their still greater use in the future. On account of their form they constitute one of the handsomest classes of bridges.

The first important steel bridge in the world was completed in 1874. It is the arch bridge which in three spans crosses the Mississippi River at St. Louis. Its arches are without hinges and their ends are firmly fixed to the piers. This is one of the most famous bridges in existence. For a long time after its construction no metallic arches were erected in this country, although many were built in Europe. In 1888, however, the highway bridge across the Mississippi River at Minneapolis was erected, consisting of two spans of 456 feet each and which still remains the longest span of any three-hinged arch. The following year the Washington bridge over the Harlem River in New York city was completed. It consists of two spans of 510 feet in the clear and has the largest two-hinged arch ribs with solid web plates.

These were followed by a number of arches of various types, the most noted of which are the two arch bridges over the Niagara River. The first one is a spandrel-braced, two-hinged arch with a span of 550 feet and replaced the Roebling suspension bridge in 1897. It accommodates the two tracks of the Grand Trunk Rail-

road on the upper deck and a highway on the lower deck. The other bridge has arched trusses with parallel chords and two hinges. It replaced the Niagara and Clifton highway suspension bridge in 1898, and as its span is 840 feet, it is the largest arch of any type in the world. The manner in which this arch was erected furnishes an illustration of the effort which is made by engineers to conform the actual conditions so far as possible to the theoretic ones involved in the computation of the stresses. Since the stresses in an arch having less than three hinges are statically indeterminate, stresses of considerable magnitude may be introduced into the trusses if the workmanship be imperfect, the supports not located with sufficient precision, and the arch closed without the proper means and care.

The Niagara and Clifton arch was first closed as a three-hinged arch and then transformed into a two-hinged arch by inserting the final member under the sum of the computed stress due to the weight of the truss, and that due to the difference between the temperature at which the closure was made and that assumed as standard in the stress computations. This stress was secured in the member by inserting it when the hydraulic jack which forced apart the adjacent ends of the shortened chords registered the required amount of pressure. The arch had been erected as a pair of cantilevers from each side extending 420 feet out beyond the supports, and when the closure was made the two arms came together within a quarter of an inch of the computed value. Such a result involving the 'accuracy of the calculation and design of the entire steel work, the exactness with which the bearing shoes or skewbacks were placed, and the perfection of the shopwork' has been truly characterized as phenomenal.* In order to reduce secondary stresses to a minimum the members were bolted up during the cantilever erection and the bolts replaced by rivets after the closure of the arch rib.

The past decade witnessed the introduction and extensive development of arches of concrete and of concrete-steel construction. In the latter kind a small amount of steel is imbedded in the concrete in order to resist any tensile stresses that may be developed. During this period more than 150 concrete steel bridges have been built in this country. In the same year in which the largest metallic arch was completed, the five concrete-steel arches of the bridge at Topeka, Kansas, were finished. The largest one has a span of 125 feet and still remains the largest span of this type in America, although it has been exceeded in Europe. Considerably larger spans are to be built this season, while others are included in the accepted design for the proposed Memorial bridge at Washington.

It is the smaller steel structures which are destined more and more to be replaced by arches of this material. The steel bridges require repainting at frequent intervals, constant inspection, occasional repairs and finally replacing by a new structure after a relatively short life, on account of rust and wear, unless it is required even sooner on account of a considerable increase in the live load. The concrete arch requires practically no attention except at very long intervals.

The safety of operating the traffic makes it desirable to have as few breaks as possible in the regular track construction of a railroad, and this constitutes an additional reason why concrete or stone arches are being substituted for the smaller openings. The decreasing cost of concrete tends to an extension of this practice to openings of increasing size. Last year, however, a bridge was completed which marks a decided departure from previous practice.

* *Engineering News*, August 4, 1898.

The Pennsylvania Railroad built a stone bridge, consisting of 48 segmental arches of 70 feet span, at the crossing of the Susquehanna River at Rockville, Pa. It is 52 feet wide, accommodates four tracks and cost a million dollars. This bridge has not only the advantage of almost entirely eliminating the cost of maintenance, but it also has sufficient mass to withstand the floods which occasionally wreck the other bridges on that river. This year the same railroad is building a similar bridge over the Raritan River at New Brunswick, N. J.

Of movable bridges the largest swing span existing was erected in 1893 at Omaha over the Missouri River. Two years later a four-track railroad swing bridge was built by the New York Central Railroad over the Harlem River in New York city, which is only 389 feet long between centers of end pins, but which weighs about 2,500 tons and is accordingly the heaviest drawbridge of any class in the world.

During the past decade a remarkable development was made in drawbridge construction by the modification and improvement of some of the older types of lift bridges and the design of several new types. At South Halstead Street a direct-lift bridge was built in 1893 over the Chicago River, in which a simple span 130 feet long and 50 feet wide is lifted vertically 142½ feet by means of cables to which counterweights are attached. Formerly, only very small bridges of this kind were used, as those, for instance, over the Erie Canal.

In 1895 a rolling lift bridge over the Chicago River was completed. In this new design as each leaf of the bridge rotates to a vertical position it rolls backward at one end. When closed the two leaves are locked at the center, but they are supported as cantilevers. This form has been found to have so many advantages for the crossings of relatively narrow streams, where an unobstructed water way is required and the adjacent shores are needed for dock room, that a score of important structures of this class have been built in different cities. The largest span that has been designed is 275 feet between centers of supports, while the widest one is to accommodate eight railroad tracks crossing the Chicago Main Drainage Canal.

About the same time and under similar conditions another type of bascule bridge was built at Sixteenth Street, Milwaukee, in which, as each leaf moves toward the shore, one end rises and the other falls, so that its center of gravity moves horizontally, thus requiring a very small expenditure of power to operate the bridge.

Several improved forms of hinged-lift bridges have also been designed and built in Chicago and elsewhere. In a small bridge erected in 1896 on the Erie Railroad in the Hackensack meadows there is only a single leaf hinged at one end and lifted by a cable attached to the other end. The counter weight rolls on a curved track so designed as to make the counter balance equally effective in all stages of opening and closing the bridge.

A novel bridge is now being built over the ship canal at Duluth which is different from any other type in this country. The general scheme is similar to that of a design made by a French engineer who built three of the structures in different countries. It consists of a simple truss bridge 393 feet 9 inches long, supported on towers at a clear height of 135 feet above high water. Instead of supporting the usual floor of a highway bridge it supports the track of a suspended car which is properly stiffened against wind pressure and lateral vibration, the floor of the car being on a level with the docks. This ferry is operated by electricity. The loaded car, its hangers, trucks and machinery weigh 120 tons. In the French design a suspension

bridge was used instead of the simple truss bridge.

A bridge is being built across the Charles River between Boston and Cambridge that deserves especial mention and marks a decided advance in the growing recognition on the part of municipal authorities of the importance of esthetic considerations in the design of public works. It consists of 11 spans of steel arches whose lengths range from 101½ to 188½ feet. Its width is 105 feet between railings. It is claimed that this bridge 'will be not only one of the finest structures of its kind in this country, but will be a rival of any in the old world.' Its length between abutments is 1,767½ feet, and it is estimated to cost about two and a half millions of dollars.

The problems incident to the replacing and strengthening of old bridges frequently tax the resources of the engineer and demonstrate his ability to overcome difficulties. Only a few examples will be cited to indicate the character of this work. In 1900 the Niagara cantilever bridge had its capacity increased about 75 per cent. by the insertion of a middle truss without interfering with traffic. In 1897 the entire floor of the Cincinnati and Covington suspension bridge was raised four feet while the traffic was using it. It may be of interest to state that the two new cables, 10½ inches in diameter, which were added to increase the capacity of the bridge, have just about three times the strength of the two old ones, 12⅓ inches in diameter, and which were made a little over thirty years before. In the same year the old tubular bridge across the Saint Lawrence River was replaced by simple truss spans without the use of false works under the bridge and without interfering with traffic. On May 25 of this year the Pennsylvania Railroad bridge over the Raritan River and canal at New Brunswick, N. J., was moved sidewise a distance of 14½ feet. Five simple spans 150 feet long and a drawbridge of the same length, weighing in all 2,057 tons, were moved to the new position and aligned in 2 minutes and 50 seconds. The actual time that the two tracks were out of service were respectively 15 and 28 minutes. On October 17, 1897, on the same railroad near Girard Avenue, Philadelphia, an old span was moved away and a new one, 235 feet 7 inches long, put in exactly the same place in 2 minutes and 28 seconds. No train was delayed in either case.

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*REPORT OF PROGRESS OF THE NEBRASKA STATE GEOLOGICAL SURVEY AND THE MORRILL GEOLOGICAL EXPEDITION OF 1901.**

IN spite of the phenomenal heat of the summer of 1901, which was of such intensity and duration that active work in the field was finally suspended, enough progress was made to justify the presentation of the matter to this society. It should be reported, first of all, that a request for funds, amounting to twelve hundred dollars, for publishing the first reports of the state geological survey, was presented to the Legislature, and was passed April 1, 1901, without comment or dissent. This may be recorded as the first sum voted by the state for the examination and publication of its resources; and, though small, it is particularly large at this juncture, for it makes possible the initial work of the state survey. Unfortunately the passage of the bill, by the Legislature, was a little too late to enable us to avail ourselves of a long-standing offer from the U. S. Geological Survey to cooperate in doing geological work in Nebraska, as soon as the state evidenced its recognition of the importance of a geological survey by offering

* Reported to the Nebraska Academy of Science, January 25, 1902.

it material support. By the time the bill was passed all appointments had been made for the U. S. Survey; nevertheless, as soon as the facts were made known to Dr. Charles D. Walcott, Director of the U. S. Geological Survey, several men were detailed to run control lines in Sarpy, Cass and Otoe counties, with the courteous and encouraging proffer of an increased force of topographers for the summer of 1902, so as to expedite the work of making maps to serve as bases for the reports of our own survey. This is cooperation in fact, and it should be stated, furthermore, that we have been favored over many of the older states, on the ground that so young a state can be excused for failing to cooperate with the national survey, better than the older and more resourceful states. Already a line of quadrangles, extending the length of the state, has been surveyed topographically, and that portion of the state west of the 103d meridian has been surveyed, and reported upon by Darton. Besides, certain papers on the water resources of the state have been prepared and published by the national survey. Some of the older states which have shown no spirit of cooperation have received fewer favors.

Field work was confined to the eastern counties, where there are the greatest number of quarries, clay pits and exposures. Mr. E. G. Woodruff spent the early part of the summer, chiefly in Sarpy County, filling in gaps left in the maps made by Fisher and Woodruff the previous summer. Mr. G. E. Condra continued the work of collecting Carboniferous fossils, especially the Bryozoa, while the Director of the State Survey made various short collecting trips. All field notes of each worker are put in typewritten form, and are uniformly bound at the end of each season; likewise all maps and photographs. These manuscript volumes, now numbering twelve books of photographs, seven books of notes, and two books of maps, are deposited with the librarian for safe keeping until such time as they can be published.

The annual Morrill Geological Expedition was rendered self-sustaining during the summer of 1901, by the sale of duplicate specimens the previous year; and one extended trip was made to the famous collecting grounds of Colorado and Wyoming, and numerous short trips to interesting localities in the state, preliminary to future work. Over thirty thousand specimens have been added to the state collections during the past three years.

Specimens, selected from the collections of the Hon. Charles H. Morrill, and from the state geological collection, which are virtually one and the same, are being photographed preparatory to figuring and describing. The material at hand for papers has outrun the publishing fund by several years. However, at the close of the present biennium, a specific publishing fund will not be asked for, for the coming biennium. Hereafter the legislative appropriation will be devoted to the preparation of reports, which will be submitted to the state printer for publication. Supplemental to the state funds for geological work is an annual fund from the University of Nebraska, varying from $200 to $500 a year.

ERWIN HINCKLEY BARBOUR.
THE UNIVERSITY OF NEBRASKA.

SCIENTIFIC BOOKS.

Fact and Fable in Psychology. By JOSEPH JASTROW. New York, Houghton, Mifflin and Co. Pp. xvii + 375.

The wild notions that are current about psychic phenomena are for the most part founded on truth. If the air is full of vagaries in this field we must in part at least lay the blame on the strangeness and suggestiveness of the facts themselves. Automatic speech and writing, hypnotism, the strange subsidences and upheavals of memory that go

by the name of 'changes of personality'—these are surely enough to fire the popular imagination to the belief that nothing is too strange to come out of psychology. In this way the whole field unfortunately comes to be represented like those regions on the old charts where no details were given, but only some figures of winged monsters and headless men.

In view of the interest in what has been called the 'borderland' of mind, the present collection of papers by Professor Jastrow is timely and will prove of service. The originals were published in various popular and scientific journals, but have in considerable part been rewritten for this volume. Taken as a whole they work in well together and contribute to a single end. His general aim is both negative and positive—negative in that he clips the wings of the soarers, the uncritical enthusiasts over mental phenomena; positive in that he attempts both to stimulate a healthy interest in many strange and interesting phenomena that do not immediately suggest the occult, as well as to point out psychologically the actual causes which lead here and elsewhere to a belief in the occult. While the spiritualists and psychical researchers are wandering and wondering in their chosen fields, Professor Jastrow has a specialist's eye on the mental machinery of these borderlanders themselves, and finds them in their way quite as instructive and as absorbing as they in their turn find the mediums and *Poltergeister*. Psychology thus stands to win in any case; if there is 'nothing in' psychical research, there is at least a great deal in the researchers.

The author points out the immense difference between 'psychical research' and psychology, especially as regards the interest and temper of the persons engaged in each. He cordially admits that some few researchers are actuated by a true scientific interest and are guided by a critical sense. The rank and file, however, are interested only in the discovery of evidences for something supernormal. In as far as the facts are explicable by familiar natural law, in so far there is for these persons 'nothing in them.' But the psychologist becomes interested just at the point where the other's attention flags. His very aim is to arrive, if possible, at a natural and normal explanation of the phenomena in question. Whatever good qualities may be hidden within the psychical research movement, Professor Jastrow believes that its sins are more than an offset to its virtues; it has withdrawn energy from fruitful fields and has done much harm to scientific psychology. In this judgment the author may be right; but so far as psychology is concerned, it is perhaps too soon to say what the real and lasting effect of psychical research will be. On the whole, the strength which the movement has developed has probably been drawn very little from psychology, just because, as Professor Jastrow has so ably pointed out, the temper and interests of the two classes of persons are so fundamentally opposed. Possibly by a kind of induction, or after the manner of antipodal tidal waves, it has positively helped toward a study of commonplace and normal mental phenomena.

As regards the special question of telepathy, the author feels that the believers here do not take sufficient account of the extent to which communication is possible through the ordinary means of sense, while the channels of communication themselves remain unrecognized; nor do they take sufficient account of mere chance coincidence. The hypothesis of telepathy, as usually understood, is scientifically repugnant because it does not keep within the bounds of psycho-physical causation. If modified to escape this objection it might become a legitimate theory, although sadly in need of facts to support it. The evidence seems to him a "conglomerate in which imperfectly recognized modes of sense-action, hyperæsthesia and hysteria, fraud, conscious and unconscious, chance, collusion, similarity of mental processes, and expectant interest in presentments and a belief in their significance, nervousness and ill-health, illusions of memory, hallucinations, suggestion, contagion, and other elements enter into the composition; while defective observation, falsification of memory, forgetfulness of details, bias and prepossessions, suggestion from others, lack of

training, and of a proper investigative temperament, further invalidate and confuse the records of what is supposed to have been observed" (p. 103).

The chapter on 'The Psychology of Spiritualism' is a good tonic for any one who may feel himself weakening in his opposition to the spiritistic hypothesis of certain trance and trick phenomena. The psychological notions which lead to the belief, as well as the difficulty of obtaining reliable evidence in its favor, are well told in this and the preceding essay on the 'Psychology of Deception.' The fact that a witness is a 'scientist' does not free him from the usual fallacies of the senses and of false inference; the testimony of such persons often breaks down just at the vital point; witness the celebrated quartette of Zöllner, Fechner, Scheibner and Weber, who were so unmercifully hoodwinked by the charlatan Slade.

This trend toward the occult, as expressed in the forms mentioned, as well as in theosophy and 'Christian science,' is due to the impulse always present in the race to look at the facts of nature in an intensely personal way. Other forms of this same attitude toward experience are found in ancient divination, in astrology, in the magic and medicine-man practices of savage life. To view the facts in their historical and anthropological perspective is an excellent check on one-sidedness here and elsewhere. With this especial aim we have two excellent studies, one of which traces the history of hypnotism through the vagaries of animal magnetism and mesmerism until the kernel of truth becomes fairly divested of its mystical wrappings, through the work of Braid; the other, with the title of 'The Natural History of Analogy,' shows the development of the belief that a person may be influenced by performing some act upon an object closely associated with him—his form in wax, his footprint, his sword, his name, and so on.

But not alone in such perspective would the author find the best antidote to the pernicious tendencies toward the occult, but also in a wholesome interest in the genuine and profitable problems of nature and of life. A considerable portion of the book is given to a study of certain mental phenomena which are not only important in themselves, but have a direct bearing on the problems discussed in the papers mentioned above. The readiness of the mind to supplement and modify its sense-impressions, so as to bring them into accord with its own prepossessions is shown by a number of simple illusions. But not alone is the power of observation thus affected by one's mental attitude, but the power of action is influenced as well. Numerous tracings of hand-movements by means of Professor Jastrow's well-known 'automatograph' are introduced to show the involuntary effect of different mental states upon the motor apparatus—interesting and suggestive in connection with 'mind-reading,' 'telepathy' and the like. On a larger scale a capital instance of the power of suggestion and social 'atmosphere' is given from certain experiences in the Government Census Office in 1890. The tabulating machines, when first introduced, caused enormous wear and tear upon the clerks who attempted to master the complicated system of symbols. But when once a considerable body of capable workers with these machines (and thus a more favorable social *milieu*) had become established, raw clerks could now be put among them, and in a few days without any appreciable nervous strain attained a speed and proficiency which the pioneer clerks had acquired only with difficulty after weeks. The volume closes with a study of the dreams of the blind, in which the author brings out the existence of a critical period at the age of from five to seven years. If blindness occurs before this, the faculty of visual dreaming is gradually lost; while the occurrence of blindness after the critical period has no serious effect upon the visual dream-life. This fact, it turns out, had already been discovered by Heermann as early as 1838; but Jastrow's rediscovery was quite independent. There is included in this chapter an account by Helen Keller of her dreams, told with the charm that always marks her writing.

It is evident that the spirit and matter of the volume seem to the present writer commendable. Beneath an easy and pliant style,

the essays are rigid, and perhaps a trifle fierce, toward the deluded believers in the occult; these will hardly feel that they are being gently shown the error of their way. And yet Professor Jastrow's opposition is of an entirely different order from the mere pooh-poohing and scientific cold shoulders to which the borderlanders have been so often treated and of which they bitterly complain. Their views are here dealt with by one who has taken the trouble to study the matters in question, who is equipped with technical training in psychology, and who pronounces judgment with discrimination, admitting many of the facts adduced, but pointing out to what different consequences they lead from what the occultists suppose.

In attributing occultism to the impulse to interpret experience personally—to see a direct significance in whatever occurs—the author is doubtless correct in the main. It would perhaps have been still more correct, however, to say that the trouble lies in seeking a *short-cut* personal interpretation, in seeking an exclusive and private significance in phenomena, and not in a personal interpretation *per se*. For many a scientist tenaciously holds to natural law and at the same time, without throwing logic overboard, interprets the system of nature personally. But he does it in a large way and by harmonizing mechanism with personal will, rather than by seeing them antagonistic. Professor Jastrow, while not explicitly saying so, too often seems to imply that natural causation and personal significance are incompatible, and that the occultist has seized the wrong term of the pair. The occultist is really in the bonds of the same error that pervades much of our science —namely, that the mechanical view of nature excludes any spiritual significance from it; and while some scientists hold to one side and give up the other, the occultist does the same, with merely an exchange of terms. One-sided science thus is one of the inducements to a one-sided occultism, and the cure is to be found in a larger view that will do justice both to our scientific conviction that things are orderly and systematic, as well as to the equally deep and respectable conviction that this order and system is pervaded with personal purpose and personal significance.

George M. Stratton.

University of California.

Altersklassen und Männerbunde, Eine Darstellung der Grundformen der Gesellschaft. Von Heinrich Schurtz. Mit einer Verbreitungskart. Berlin. 1902. 8vo. Pp. 458.

This massive volume is devoted to the thesis that the true beginning of those artificialities of human life that we call society is not to be sought in the family, the sexual union, the Mutterrecht, which is an exaltation of naturism; but in purely voluntary aggregations of males, called men's associations, and the classification of these by age, forming the society of the ancients. The author confesses that his attention was first called to the subject by the wide distribution and different forms of bachelors' quarters among the less cultured peoples of the earth. So many necessary acts of life require cooperation that artificial social structures of more and more complicated character grow out of the very nature of the case. War, so far from being an exception to the rule, proves it, since its struggles occasion more perfect and solid unions. It is well known and has often been commented on that, in America, while children were generally named for the mother, there was going on in many tribes a transition to father-right. A curious modern phase of this assertion of man's rights is a rôle played by the profession of interpreters, who are men of almost unlimited sway in the tribes having business in Washington City.

Doctor Schurtz in his introductory chapter prepares the way for the detailed study by explaining the natural and artificial analysis of society—that dependent on sex life and that based on purely interested and cultural grounds. The classification by age, whether allied or not with the question of blood kinship, is the earliest form of artificial grouping. This with its curb on the life of promiscuity is worked out in the second chapter. The author goes into the fullest detail with the description of the men's houses in all parts of the world.

Clubs and secret societies occupy the fourth chapter and nearly one third of the volume.

The conclusions to be drawn from the contents of the volume devoted to the existence and the future of culture society are scarcely touched, though they are so full of meaning. The author hints that altruistic ethical philosophy, on the strength of the facts here assembled, demands now a radical revision, since manifestly out of the sex and family impulses on the one hand, and the pure and simple impulses of social organizations on the other, two quite different and frequently downright antagonistic kinds of moral codes must arise. The struggle between these has been frequently remarked and treated in a poetic fashion, but the knowledge of their true significance will be made possible for the first time by the facts here set forth, and not only in the realms of custom, but in all the areas of human activity, the two sets of impulses are playing against each other and building up forms of society, in order subsequently to pull them down and destroy them.

There ought to be a good English translation of this work, which, ignoring the necessity of promiscuity at any time in human society, finds explanation of artificial social structures and functions in the inventive faculty, which has been able to create innumerable associations for men in their varied emergencies.

O. T. MASON.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF BIOLOGY.

A REGULAR meeting of the Section of Biology was held on April 14, Professor Bashford Dean presiding. The following program was offered:

J. H. McGregor, 'The Ancestry of the Ichthyosauria.'

A. G. Mayer, 'Color Patterns in Lepidoptera.'

C. C. Trowbridge, 'The Function of Interlocked Emarginate Primaries in Soaring Flight.'

Dr. McGregor accepted Baur's view that the Ichthyosauria are derived from Permian Rhynchocephalia, but stated that in a study of the Belodontia he had found new evidence as to the nature of the intermediate forms. The latter group is of undoubted Rhynchocephalian origin, and may almost be considered as a subdivision including forms modified for aquatic life. A comparison of Belodonts and Ichthyosaurs shows that both have evolved in the same direction, though modification has proceeded further in the Ichthyosaurs, which were marine in habit. Almost all of the skeletal features of the two orders are reducible to a common type, and, although not directly ancestral, the Belodonts must be considered as standing very near the line of descent of the Ichthyosaurs; the two orders probably had as a common ancestor some aquatic Rhynchocephalian of the upper Permian or lower Trias. The Ichthyosauria are thus brought into relation with the Archosaurian branch of the Reptilia.

Dr. Mayer presented the results of his study of the color patterns of 1,173 species of Lepidoptera: 453 *Papilio,* 30 Ornithoptera, 643 Hesperidæ, and 47 *Castina.* Counting sexual differences, 1,340 individual insects were examined; 542 *Papilio,* 59 Ornithoptera, 688 Hesperidæ, and 51 *Castina.* The number of rows of spots, bands, or combination markings upon the wings were counted, and as well the number of spots in each individual row, and the number of interspaces over which each band extended; the results show that each row of spots or bands exhibits a decided tendency to be of uniform color throughout, that rows very rarely break at or near the middle of their extent, and that the end spots of a row are more variable than those spots near the center. 'Frequency polygons' were obtained from the above-mentioned data, for the rows of markings, for the number of spots in each row, and for the extent of bands measured in interspaces. Eight such frequency polygons were determined for the spots and bands on the upper and lower surfaces of the wings in the group of Papilio + Ornithoptera, Of the four representing the conditions in the fore-wing, three exhibit two well-marked maxima, the numbers being arranged in descending series on either side of each. These maxima are three and nine spots, or bands extending over three or nine interspaces. If,

now, *Papilio* be divided into three subgenera, *Papilio* s. str., *Cosmodesmus*, and *Pharmacophagus*, and be still further separated into the African, Indo-Australian, Europo-Siberian, and American forms, it is found that the insects of the subgroups still display the tendency to have three or nine spots, or bands extending over three or nine interspaces. This is not a matter of correlation, for only 32 of the 453 species of *Papilio* display *both* three and nine spots upon their fore-wings. It is somewhat difficult to explain this condition upon the hypothesis of natural selection, owing to the fact that *Papilios* of widely separated regions show the same tendency to produce these two maxima in the same manner. The Hesperidæ and *Castina* show no such tendency, hence it is not universal for Lepidoptera. If it be due to natural selection acting upon *Papilios* and restricting them to this condition, such selection must be universally operative in the case of *Papilio*, but not in the other species. It is easier, therefore, to assume a race tendency in *Papilio* to produce either three or nine spots upon the fore-wing, or bands extending over three or nine interspaces. Other results, quantitatively expressed, were brought out by the author.

Mr. Trowbridge gave the results of observations on flying birds for the purpose of showing that the emarginate primaries of hawks, eagles and certain other birds are interlocked in flight. The speaker referred to his original paper on the subject in which the theory was set forth, which was presented by the late Professor W. P. Trowbridge before the National Academy of Sciences and the New York Academy of Sciences. The paper created some discussion in SCIENCE at the time, participated in by Dr. Elliot Coues, Professor Newberry, Professor Trowbridge and others. Mr. Trowbridge showed by a number of diagrams and photographs that the primary feathers of a number of birds are emarginate near their ends, and that the webs of the feathers are so shaped that when they are overlapped, a curved and rigid aeroplane is formed at the end of the wing, which, he considered, is of considerable advantage in swift sailing flight. The emarginations of the primaries of hawks and eagles are particularly pronounced, and permit firm interlocking. A table of observations was given, showing that the interlocking of the primaries does take place, the data having been obtained at New Haven during the autumn flights of hawks along the Connecticut coast. It appears that in the case of one species of hawk examined, ten wings out of forty had all five primaries interlocked, and that the number of wings having sixty per cent. of the primaries interlocked was twenty-nine, or 72 per cent. of the total number, forty. It was concluded that emarginate primaries of hawks and other birds are interlocked in flight on the following grounds: (1) it has been found that the webs of such feathers of hawks that had just been killed usually show deep notches where they have rested against one another, which notches could only result from habitual interlocking of the primaries; and (2), in every case of over 25 hawks killed while flying and examined immediately after they fell, *some* primaries were interlocked (several slightly wounded birds not included). In the case of 19 perfect specimens of one species, 67.9 per cent. of all emarginate primaries (190) were found to be interlocked. While it is not possible at present to show when the emarginate primaries are interlocked in flight, the indications are, however, that this occurs when the wing is partly flexed, as in the case of hawks sailing rapidly through the woods and flying in a strong wind. The important functions of interlocking appear to be (1) to make more rigid the outer portion of the wing, that part of the aeroplane formed by the primaries, and (2) to produce a curve of the wing which enables the bird to have a better control of its swift flight through the air than the unlocked condition would permit. The end of the bird's wing when the primaries are interlocked becomes shaped somewhat like the blade of a propeller screw. The interlocking also would keep the primaries extended without muscular exertion on the part of the bird.

Considerable discussion was aroused by Mr. Trowbridge's paper. Dr. Jonathan Dwight, Jr., presented a series of arguments against the theory of the speaker, to the effect, in

brief, that in the absence of a proper controlling musculature, any such interlocking as that described could be brought about only by accident; that habitual interlocking would bring about, furthermore, conspicuous wearing of the vane in the areas of contact, a phenomenon not observed in emarginate primaries; and that he concluded from his extensive studies upon feathers and feather structure, that habitual interlocking did not take place. Mr. Frank Chapman, with a series of fine lantern slides of birds in actual flight, demonstrated that in some soaring birds, at least, which possess emarginate primaries, these feathers are certainly spread and not interlocked. Mr. Chapman agreed with Dr. Dwight that the facts tend to support Allen's theory of the origin of emargination, namely, that aerial friction wears down the web; and that no such function is to be attributed to emarginate primaries such as that ascribed by Mr. Trowbridge. Prolonged discussion followed, participated in by Mr. Trowbridge, Dr. Dwight, Mr. Chapman, Professor Dean, Professor Crampton and others.

HENRY E. CRAMPTON,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

AT the April meeting of the Section Mr. Percival Lowell gave a very interesting paper on 'Modern Mars,' based on a series of maps of Mars.

1. Map-making of Mars began with Beer and Mädler in 1840. Since then many charts have been constructed of the planet. Some of these are so old as to have been more or less forgotten, some so new as not yet to be known. Collection and comparison of such of these maps as have marked advances in the subject lead to some not uninteresting conclusions. Such are presented in the accompanying series.

2. The series consists of twelve maps.

I.	Beer and Mädler	1840
II.	Kaiser	1864
III.	Dawes by Proctor	1867
IV.	Résumé by Flammarion	1876
V.	Schiaparelli	1877
VI.	"	1879
VII.	Schiaparelli	1882
VIII.	"	1884
IX.	Lowell	1894
X.	"	1897
XI.	"	1899
XII.	"	1901

3. These maps fall naturally into three groups, dividing the history of areography into as many stages.

I. Those from 1840–1877
II. Those from 1877–1892
III. Those from 1892–1902

4. The maps of the first group are characterized by large patches of light and dark areas. Maps I.–IV. show these patches, and by their agreement prove that the patches are permanent in place. For the maps are the work of different observers made at different epochs of time.

5. The maps of the second group are distinguished by a network of fine, straight lines covering the bright areas of the disk, the 'canals' of Mars. This was the work of Schiaparelli.

6. The maps of the third group are differentiated by a similar system of 'canals' in the dark regions. This is the work since Schiaparelli. It has resulted in a complete change in the belief as to the character of these 'seas'; the permanency of the lines showing that the background must be land, not water.

7. Inspection of the series results in three deductions:

I. That the whole series are in fundamental agreement.

The basic features appear directly throughout the first period and as a groundwork upon which subsequently discovered detail is imprinted in the second and third.

8. The second deduction from these data is:

II. That the almost inconceivable regularity in the 'canals' was an evolution in perception forced upon Schiaparelli by the objects themselves; not a feature imparted by him to them.

His first map, in 1877, showed them as arms or inlets of the sea penetrating the continent to great distances, but not characterized by remarkable regularity of form. His

second map, in 1879, shows them narrower, straighter and in every way more peculiar. His third map, in 1882, presents them as of geometric precision; as he himself remarks, as if laid down by rule and compass. His fourth map shows that they afterward kept such a character.

Had their precision been of his devising, they should not have gained in it as time went on and his eye grew versed in decipherment. That they did so implies that the recognition was forced upon him from without.

9. The third deduction is:

III. That an evolution in detail marks the series, and can be traced steadily on from the beginning to the end. The additions made in each period find themselves superposed upon the work of the period before. Similarly each map of any given period adds to its predecessor and is corroborated and extended by its successor. Thus a chain of evidence is made by them whose strength depends upon this very intertwining of results.

The discussion called forth by the paper was participated in by many, among whom was Mr. Nikola Tesla. S. A. Mitchell.

TORREY BOTANICAL CLUB.

A meeting of the Club was held at the New York Botanical Garden on May 28.

The first paper on the program was by Mrs. N. L. Britton under the title of 'Remarks on West Indian Mosses.' Comments were made on several questions of synonymy and nomenclature arising from a study of collections recently made in Porto Rico by Mr. A. A. Heller and by Professor Underwood, and in St. Kitts by Dr. Britton. Attention was directed particularly to the genus *Sematophyllum* Mitt. 1864 (=*Raphidostegium* De Not. 1867=*Rhynchostegium*, section *Raphidostegium* Br. & Sch. 1852). This genus is chiefly tropical or subtropical in its distribution, though eleven species are known to occur in North America, north of Mexico.

The second paper was by Dr. P. A. Rydberg on 'Some Genera of the Saxifragaceæ.' The speaker presented some of the results of studies intended as a contribution to a projected work on the flora of North America. The family name Saxifragaceæ was used in a restricted sense, excluding *Ribes, Hydrangea, Philadelphus, Parnassia, Itea,* etc. The members of the family in this narrower sense are all herbaceous plants, with the exception of a single species of *Heuchera* which has a sort of aerial woody stem. Dr. Rydberg commented especially upon the genera *Bolandra, Therofon, Telesonix, Hemieva, Tiarella, Heuchera, Tellima, Lithophragma, Mitella,* and *Chrysosplenium,* referring to the geographical distribution and number of species of each. Heuchera is the largest of these genera, being represented by 58 species in North America including Mexico. The paper was discussed by Dr. Britton and others.

Professor F. S. Earle made a brief report on a recent trip to western Texas and Eastern New Mexico, stating that 800 numbers of botanical specimens were collected. April and May seemed too early in the season for finding many herbaceous plants in flower, and this was especially the case with the monocotyledons.

Dr. N. L. Britton showed specimens of *Washingtonia longistylis* collected a few days previously near Washington, D. C., differing from Torrey's type of the species in greater hairiness.

Mrs. Britton alluded to the organization of 'The Wild Flower Preservation Society of America.' Professor Earle remarked upon the region west of the Pecos River, where vegetation has been nearly exterminated by overstocking with cattle, as a proper field for the activities of the society.

Dr. MacDougal showed a corm of *Amorphophallus,* kept for twenty months in a dark room, where it had flowered. New buds, apparently adventitious, had formed near its base.

Marshall A. Howe,
Secretary pro tem.

DISCUSSION AND CORRESPONDENCE.

ZOOLOGICAL NOMENCLATURE IN BOTANY.

To the Editor of Science: On returning from Central America I find Dr. Dall's note

on 'Botanical Nomenclature' in your issue of May 9 (p. 749), and am gratified, of course, by his approval of the suggestion that the disposition of objectionable names or caconyms be separated from the body of nomenclatorial legislation and left to a permanent committee or academy. On the other hand, I greatly regret my failure to have made sufficently plain the fundamental importance of generic types as necessary to stability in the nomenclature of genera.* Had this principle been adequately presented Dr. Dall would have realized that it is not provided for in any existing legislation, botanical or zoological. The most serious deficiency of botanical nomenclature is therefore not avoidable by 'rules accepted by practically all zoologists,' among whom there is in this respect quite as much diversity of faith and practice as with botanists.

In the formulation of rules upon some of the less important details the zoologists may have made better progress than their botanical brethren, but the illustrations cited by Dr. Dall seem rather unfortunately chosen. Vernacular names, for example, are rejected by all codes, that is, when they occur in nonscientific writings, but both botanists and zoologists from the pre-Linnæans to the present generation have exercised the privilege of adopting such names into scientific literature, often in large numbers. Whether a name is 'vernacular' or 'scientific' has thus been allowed to depend upon the nature of the publication rather than upon the origin of the term, so that unless a new canon of criticism can be formulated the nomenclatorial atrocities of Hernandez cannot be excluded because of their barbarian origin without disturbing hundreds of commonly accepted designations of both plants and animals.

Dr. Dall declares that 'ninety-nine hundredths' of our remaining tribulations would disappear by the use of Linnæus' 'Systema Naturæ,' Ed. X., as the starting point of nomenclature, but unless it be the advantage of following the zoologists he gives no intimation of any reason why 1759 is a better date than 1753. As a matter of fact, the plants were presented under the binomial system of nomenclature five years before the animals, and Linnæus but carried out with the animals in 1758 what he had accomplished with the plants in 1753. Botany had a far larger popularity and a much greater and more rapid development than zoology in the seventeenth and eighteenth centuries, which may explain the stronger attachment to mediæval traditions and the greater difficulties of botanical reforms, but this more persistent conservatism will be beneficial if it compels us to master the complex problems of taxonomy and prevents too ready assent to such partial and inadequate readjustments as have found favor among some zoologists.

The historical development and dominant traditions of the two sciences have been somewhat different, but nobody will seriously maintain that there is any essential divergence between the taxonomic requirements of botany and those of zoology, and an adequate solution discovered in the one science will not be lightly neglected in the other. The so-called Paris or DeCandollean code of 1867, to which Dr. Dall also advises botanists to hark back, was not copyrighted, and yet the zoologists did not adopt it, doubtless because they thought themselves able to do better. Like the supplementary Rochester code, it was an important step in the right direction, but it did not exhaust the possibilities of progress. It was evidently prepared as an advisory or preliminary document, and is quite lacking in the logical arrangement and definite statement requisite in nomenclatorial legislation. Moreover, it was based on pre-evolutionary conceptions of nature, and as a system of recording the results of biological study it does not meet our present necessities.

O. F. COOK.

WASHINGTON, June 10, 1902.

* SCIENCE, N. S. XV.: 646; references to previous discussions of the same subject are given on page 656.

COILED BASKETRY.

PROFESSOR MASON'S note under the above heading in SCIENCE for May 30 is another reminder that we know but little of the arts of our eastern Indians at the period of their

first intercourse with Europeans. That there is little evidence of the use of coiled basketry among them at that time is not surprising, for the early writers were not technologists and were satisfied with recording incidentally the most meager facts concerning the arts and customs of the natives with whom they came in contact.

Basketry of any kind is rarely found in graves or its impressions upon pottery east of the Rocky Mountains. The burial caves have, however, furnished a very few examples of the widely distributed twined weaving, but so far as I know, no examples of the coiled pattern. We must look therefore to existing tribes for the principal evidences of the occurrence in ancient times of different types of this branch of textile art.

The isolated examples of coiled basketry occurring east of the Rocky Mountains noted by Professor Mason may be supplemented by a number of specimens in the Peabody Museum at Cambridge obtained twenty-seven years ago from the Ojibwa Indians of Lake Superior. The coils are of sweet grass and are about one-fourth of an inch in diameter. They are joined with common sewing thread, the stitches being continued from the edge towards the center of the basket, and not following the coils as is usual, the mode of construction having somewhat degenerated.

I see no good reason for attributing this form of basketry among the Ojibwa to European influence. The Algonquians in early historic days were expert basket makers. The excellence and variety of the old basket work of the New England Indians for example is represented to-day only by the degenerate splint basketry which is not worthy of a place upon the shelves of a museum.

There is not to my knowledge a single example of woven basketry extant from New England that may be considered typical of any one of the many primitive types from these states referred to in the early records. Gookin, writing in 1674, tells us of "several sorts of baskets, great and small; some will hold four bushels or more, and so downward to a pint. * * * Some of these baskets are made of rushes: some of bents [coarse grass], others of maize husks, others of a kind of silk grass; others of a kind of wild hemp; and some of the barks of trees, many of these very neat and artificial, with the portraitures of birds, beasts, fishes and flowers upon them in colors." The soldiers under Capt. Underhill, after destroying the Pequot fort in Connecticut, in 1637, brought back with them 'several delightful baskets.' Brereton (1602) found baskets of twigs 'not unlike our osier.' Champlain saw corn stored in 'large grass sacks.' Josselyn writes of 'baskets, bags and mats woven with sparke, bark of the lime tree and rushes of several kinds dyed as before, some black, blue, red, yellow.' In 1620 the Pilgrims found in a cache at Cape Cod a 'great new basket,' round and narrow at the top, and containing three or four bushels of shelled corn, with thirty-six goodly ears unshelled. The New England Indians were probably not more expert basket makers than other tribes to the west and south.

Does not the fact that the three distinct forms of weaving, twined, checker and coiled, are still found among the Ojibwas seem to indicate a survival of these types from prehistoric times? Charles C. Willoughby.

Peabody Museum.

IRIDESCENT CLOUDS.

To the Editor of Science: Iridescent clouds are such comparatively rare phenomena that notes on individual occurrences of them are not superfluous. On June 11, I had an opportunity to see some wonderfully fine examples of these interesting clouds. It was a fine summer day; the sky a deep blue, with scattered cirro-stratus patches drifting across it from west to east, and the wind SW. About 11.30 A.M. a small detached cirro-stratus cloud, roughly oblong in shape, and at that time about 15° to 20° from the sun, attracted my attention because of its dazzling whiteness, quite unlike the appearance of ordinary clouds. Very soon colors began to appear, and at the end of about five minutes there were developed some faint bands of color, a faint pinkish tint being uppermost; then a yellowish-green, and then below that a delicate bluish green. These bands were roughly parallel with the

(apparent) upper edge of the cloud. The latter moved in an easterly direction, away from the sun, and in four or five minutes the colors had faded away. A few minutes later another patch of the same kind of cloud, also drifting east, occupied about the same position as that taken by the first cloud at the time it became iridescent, and this second cloud, in its turn, showed faint rainbow coloring. This phenomenon was repeated three times, and in no case did the iridescence last more than four or five minutes. The colors were brightest in the second cloud. There were a good many patches of cirro-stratus in different portions of the sky at the time, and several of them showed waves. Light local showers occurred during the evening or night following.

Studies of iridescent clouds have been made in Europe by Ekholm, Schips, Mohn, McConnel, Hildebrandsson, Kassner and others. A useful article in this subject, by Arendt, will be found in *Das Wetter* for 1897, pp. 217–224, and 244–252. In the *Jahrbuch für Photographie und Reproductionstechnik* for 1900, in a brief article on the same subject, by Kassner, there are some half-tones of iridescent clouds. The views do not, of course, reproduce the colors.

R. DEC. WARD.

HARVARD UNIVERSITY.

PHYSICS AND THE STUDY OF MEDICINE.

TO THE EDITOR OF SCIENCE: Dr. Trowbridge, in his paper on 'The Importance of a Laboratory Course in Physics in the Study of Medicine,' SCIENCE, May 30, 1902, mentions the Johns Hopkins as one of the medical schools that do not offer a laboratory course in physics. His statement is correct, but the inference that might be drawn from it, namely, that the Johns Hopkins does not consider such a course an important part of the preparation for medicine, is entirely incorrect. Those who are familiar with the requirements for medical study in this country are aware, of course, that from its foundation in 1893 the Johns Hopkins has required from each of its entering students certificates not only of a college course in physics, but of a laboratory course as well. If, as frequently happens, the student has not been able to get a laboratory course in the college from which he comes, he is entered as conditioned in laboratory physics and is obliged to absolve this condition during his first medical year by attendance upon a course provided for such cases.

W. H. HOWELL.

JOHNS HOPKINS MEDICAL SCHOOL.

SHORTER ARTICLES.

ON A METHOD IN HYGROMETRY.

DURING the course of my work on the diffusion of nuclei in hydrocarbon vapors, I noticed that on certain days the experiments were apt to break down; the column of air within the tower-like receiver, instead of showing on exhaustion the sharp plane of demarkation between the nucleated air below and the pure air above, was liable to condense as a whole, almost explosively. This occurred at a definite pressure and after condensation had already begun in the nucleated region. Suspecting that the discrepancy might be due to the hygrometric state of the atmosphere, I made the following tests which bear out this surmise. The first column shows the pressure decrement on exhaustion, the second the effect produced on the nucleated atmospheric air in the dry receiver. In the second and third parts of the table, the results of artificially moistening and of drying the air are at once apparent.

1. Room Air.			2. Same, Dampened.			3. Same, Dried Over $CaCl_2$.		
Pressure Decrement.	Receiver.	Hygrom. State.	Pressure Decrement.	Receiver.	Hygrom. State.	Pressure Decrement.	Receiver.	Hygrom. State.
cm.			cm.			cm.		
10	clear.	—	10	clear.	—	10	clear.	—
12	"	—	11.5	clear?	.40	15	"	—
12.7	"	—					"	—
13.4	"	3.4	12	fog.	.39	17		
14	fog.	3.3	12	"	.39	19	"	.21
14	"	3.3	11.5	clear?	.40	no fog obtainable.		

It seems to me probable that a method of hygrometry is here suggested which is worth a trial and for which suitable apparatus could be easily devised. In other words, artificially nucleated air is suddenly cooled by expansion until a fog just appears. The dew point is computed from the pressure decrement thus determined. If t be the temperature of the air in degrees centigrade and p its pressure, and if the air is cooled from 20° and 76 cm., we write approximately,

$$dt/(t+273)=.29\,dp/p,$$

so that roughly 1 cm. of pressure decrement will correspond to a little more than one degree of temperature decrement in a dew point apparatus and more than 10 or 15 cm. of pressure difference will rarely be required.

C. Barus.

Brown University,
Providence, R. I.

SCLEROTINIA FRUCTIGENA.

Among the many fungi connected with plant diseases, *Monilia fructigena* is one of the most notable. Its life history has been a subject of study by many in this country and in Europe. Woronin has made perhaps the most complete study, and although the ascospore stage was not found, he did not hesitate to place the species of the genus *Sclerotinia*. The apothecia have not been observed, to my knowledge, by any one who has had the subject under investigation, although they have been sought for by many.

This spring, during April and May, I found this stage in considerable abundance in many peach and plum orchards in Maryland. In fact, some specimens were noticed in every orchard examined where brown rot had appeared during the year 1900. The apothecia appear with the flowers of the peach, and arise from the sclerotia in the 'mummy' fruits covered by slightly moist soil, especially where they have not been disturbed for a year. They are from 3 to 12 mm. in diameter and the stipe is long enough to bring the disk just above the ground. The apothecia dry up in a few weeks and are then very difficult to find, although with a careful search they can probably now be discovered in northern peach and plum orchards. A few of the ascospores retain their power of germination up to the present time.

By means of numerous cultures followed out very carefully on agar, bouillon, on sterile dried apple and prune and also on green peaches and plums, I have produced the conidial stage (*Monilia*) from the ascospores. The peach petals are also easily infected with the 'blossom blight' by placing the ascospores in contact with them. It may be that the blighting of peach and plum flowers comes largely from the ascospores.

J. B. S. Norton.

College Park, Md.

QUOTATIONS.

THE HOUSE OF DELEGATES OF THE AMERICAN MEDICAL ASSOCIATION.

The House of Delegates of the American Medical Association was created to be the legislative assembly of the medical profession of the United States. Its first meeting at Saratoga brought out prominently the possibilities for effective work that are inherent in its method of organization. That the work of this body at its first meeting was not perfect need hardly be said, as no new machine ever made its trial trip without developing some friction. However, it can truthfully be said that the House of Delegates at Saratoga so performed its duties as to encourage its friends and as to quiet its critics. One criticism somewhat frequently passed upon it was that its work was not deliberative. Matters were referred to various committees whose report was adopted or rejected with but scant discussion. The reason for this is not far to seek. The men composing the House of Delegates were the same men who for years have been endeavoring to get the old general session to legislate intelligently upon various topics that demanded elucidation at the hands of the representative gathering of American physicians. Their experience with that method had taught every one of them that prolonged discussion meant always defeat or postponement. This lesson could not be readily unlearned, and so they were moved by a somewhat feverish haste to have important matters passed upon before they were killed by tiresome discussion. Be-

cause of the large membership of the House it is clear that much of its work must be done through committees, just as the work of Congress and of our State legislatures is accomplished. Yet we must have ample provision for free debate upon important topics before they are finally passed upon. We are gratified to learn that the new Business Committee which will arrange a program for the next meeting of the House already has under consideration a plan to bring out full discussion in such a way as to ensure no interference with the decisiveness of final action. With this provided for the House of Delegates will be fully entitled to the respect, confidence and suport of all American physicians.—*American Medicine.*

THE House of Delegates.—This new legislative body of the American Medical Association gave ample evidence that it can dispatch work much more efficiently than was possible in the general session heretofore. It contained many representative men, who showed a willingness to devote themselves to its business at no little sacrifice to themselves. It had to struggle against some disadvantages, due to the newness of the work and to the fact that an untimely fire at Saratoga drove it from its original quarters. The urbanity of President Wyeth and his rather low articulation were, perhaps, not conducive to a quick dispatch of business, but after the first day the progress made was more expeditious. This first experience has proved several things. The sessions should, if possible, be held at times when the sections for scientific work are not in session. Many men were kept from reading papers because they were conscientiously attending the House of Delegates. Others remained away from the House, because the sections were more interesting. If this is allowed to continue, the House will soon be attended by few others than the political wire-pullers who have at times dominated the affairs of the Association to its disadvantage. The House would do better to meet early in the morning or in the evening during the time devoted to entertainments than during the time assigned for section work. It is probable that one of the vice-presidents or chairmen elected by itself should be selected to occupy the chair in most cases, so that the President might be free for social and scientific duties. The President of the Association is usually elected for scientific services rendered to the profession and the public, and is not necessarily a good parliamentarian. The House of Delegates should be empowered to select a man with a strong voice, a strong backbone and a knowledge of parliamentary law, combined with absolute impartiality to preside over its deliberations. This would insure sessions beginning at the exact minute agreed upon and would dispatch business in a quick, just and efficient way. On the whole the House of Delegates was, and promises to continue to be, a success.—*Philadelphia Medical Journal.*

THE ELIZABETH THOMPSON SCIENCE FUND.

ON June 9, 1902, the twenty-seventh meeting of the Board of Trustees for the Elizabeth Thompson Science Fund was held at the Harvard Medical School, Boston, Mass.

Messrs. Bowditch, Pickering and Minot were present.

The following officers were elected:

President, Henry P. Bowditch; *Treasurer,* Charles S. Rackemann; *Secretary,* Charles S. Minot.

The report of the Treasurer, ending May 23, 1902, was read and accepted. It shows a balance of income on hand of $2,586.01.

It was voted to consider as closed the records of the following Grants:

33. Julien Fraipont.
81. John Milne.
82. W. O. Atwater.
86. H. H. Field.
87. S. H. Scudder.
88. P. Bachmetjew.
89. E. S. Faust.
92. E. W. Scripture.
95. F. T. Lewis.

The Secretary reported that Grant No. 95, of $125, had been made to Dr. F. T. Lewis, Cambridge, Mass., for investigation of the development of the vena cava inferior, being agreed to by correspondence, and that the work had been completed and published.

The Trustees greatly regretted to be obliged to decline forty-five applications, many of which were highly deserving of aid.

It was voted to make the following new Grants:

96. $150, to Professor H. E. Crampton, Columbia University, New York, for experiments on variation and selection in Lepidoptera.

97. $100, to Dr. F. W. Bancroft, University of California, Berkeley, Cal., for experiments on the inheritance of acquired characters.

98. $125, to Dr. J. Weinzirl, University of New Mexico, Albuquerque, N. Mex., for investigation of the relation of climate to the cure of tuberculosis, it being agreed that if the work justifies it the same amount will be granted next year.

99. $300, to Professor H. S. Grindley, University of Illinois, Urbana, Ill., for investigation of the proteids of flesh.

100. $300, to Dr. H. H. Field, Zürich, Switzerland, to aid the work of the concilium bibliographicum.

101. $250, to Professor T. A. Jaggar, Harvard University, Cambridge, Mass., for experiments in dynamical geology, provided the Secretary receives the necessary assurance that the work can be undertaken with reasonable promptitude.

102. $50, to Dr. E. O. Jordan, University of Chicago, Chicago, Ill., for the study of the bionomics of *Anopheles*.

103. $300, to Dr. E. Anding, München, Bavaria, to assist the publication of his work 'Ueber die Bewegung der Sonne durch den Weltraum,' but the grant is conditional upon other means being also secured by the author sufficient to accomplish the publication.

104. $300, to Professor W. P. Bradley, Wesleyan University, Middletown, Conn., for investigations on matter in the critical state.

105. $300, to Professor Hugo Kronecker, Bern, Switzerland, for assistance in preparing his physiological researches for publication.

106. $300, to Professor W. Valentiner, Grossh, Sternwarte, Heidelberg, Germany, to continue the work of Grant No. 93 (Observations on variable stars). Signed,

CHARLES S. MINOT,
Secretary.

THE PITTSBURGH MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE fifty-first annual meeting of the American Association, held this week at Pittsburgh, opened auspiciously, three hundred and fifteen members being registered on Monday morning. A full report of the meeting will be given in the issue of SCIENCE for next week; here it can only be said that at the beginning of the week it was evident that both the scientific programs and the social arrangements were excellent in all respects. This may be illustrated by the statement that sixty-nine papers were entered to be read before the American Chemical Society and the Section of Chemistry, and that the local committee provided forty-two excursions. The retiring president, Dr. Minot, gave the admirable address that is printed above. The vice-presidential addresses of Professor Jacobi and Dr. Galloway are also printed in this issue of SCIENCE, and those by Professor MacMahon, Professor Brace, Professor Van Hise, President Jordan, Dr. Fewkes and Mr. Hyde will follow. Full reports of the meetings of the sections and of the affiliated societies will be given in early issues of this journal.

SCIENTIFIC NOTES AND NEWS.

THE Paris Academy of Sciences has elected M. Amagat a member of the section of physics in succession to M. Cornu.

THE Academy of Sciences of Vienna has elected Lord Rayleigh a corresponding member.

THE list of coronation honors in great Britain closes with the announcement that King Edward has instituted a new Order of Merit to be bestowed for well-earned distinction in any profession, foreigners to be included as honorary members. The original members of the order include Lord Kelvin, Lord Lister, Lord Rayleigh and Sir William Huggins. Lord Lister and Lord Kelvin have also been made privy councillors; knighthood has been conferred on Dr. Oliver Lodge, and Professor William Ramsay has been made Knight Companion of the Order of the Bath.

THE honorary Doctorate of Laws was conferred upon Director W. W. Campbell, of the Lick Observatory, by the University of Wisconsin on July 19.

YALE UNIVERSITY has conferred its Doctorate of Laws on President Nicholas Murray But-

ler, of Columbia University, and on Dr. Roswell Park, director of the New York State Pathological Laboratory at Buffalo.

MIDDLEBURY COLLEGE has given its LL.D. to Professor Brainard Kellogg, of the Brooklyn Polytechnic Institute.

DR. JOHN M. CLARKE, New York state paleontologist, has been given the degree of LL.D. by Amherst College.

THE Alabama Polytechnic Institute has recently conferred the degree of M.A. on Professor F. S. Earle, assistant curator in the New York Botanical Garden, in recognition of his extensive researches in the fungi and in plant pathology.

THE Accademia dei Lincei has awarded Mr. Marconi a prize of the value of about $2,000 for his work in wireless telegraphy.

THE degree committee of the special board for medicine of Cambridge University are of opinion that the works, submitted by Thomas Henry Jones, Trinity-hall, advanced student, on (1) the experimental bacterial treatment of Cambridge sewage; (2) the bacteriological test for sewage-pollution in drinking water; (3) notes on the oxidizing bacteria of sewage, are of distinction as records of original research.

PROFESSOR A. W. EVANS, of Yale University, and Mr. Percy Wilson, of the New York Botanical Garden, have gone to Porto Rico to make some further investigations and collection of the flora of the island for the New York Botanical Garden. Special attention will be given to the small area of primitive forest yet remaining on the island.

MR. GEORGE V. NASH, of the New York Botanical Garden, has recently returned from an extensive trip to England, France, Germany and Holland made for the purpose of completing some botanical studies and securing material for the collections of the New York Botanical Garden.

THE *Botanical Gazette* states that Dr. B. E. Livingston and Mr. H. N. Whitford, assistants in botany, and Mr. C. D. Howe, fellow in botany, of the University of Chicago, have been appointed collaborators in the Bureau of Forestry, Department of Agriculture, for the year beginning July 1, 1902. Dr. Livingston will work on some forestry problems in the northern part of the southern peninsula of Michigan; Mr. Whitford will continue some investigations already begun in the forests of the Rocky mountains in the northwestern part of Montana, and Mr. Howe will do similar work in the vicinity of Burlington, Vermont.

THE work in irrigation provided for by Congress will be under the direction of the Director of the Geological Survey, Dr. Charles D. Walcott, and of Mr. F. H. Newell, chief of the Hydrographic Bureau.

DR. HEBER D. CURTIS has been appointed assistant in the Lick Observatory for three years, dating from the departure of the Mills Expedition to Chili, with principal duties in spectroscopy. Dr. Curtis is a graduate of Michigan University, A.B., '92, and A.M., '93; was professor of mathematics and astronomy in the University of the Pacific 1896–1900; was an eclipse observer in Georgia, 1900, and Sumatra, 1901; and has this year taken his Ph.D. degree at the University of Virginia.

THE election of two American members of the Executive Council of the Association Internationale des Botanists by votes of the American members of the Association took place on June 1. Professors C. E. Bessey and W. F. Ganong were elected.

MR. GEORGE GRANT MACCURDY has been chosen to represent the Paris Society of Anthropology at the coming International Congress of Americanists to be held in New York, October 20–25, 1902.

AT the meeting of the American Climatologic Association at Los Angeles the following officers were elected for the ensuing year: *President,* Dr. Norman Bridge, Los Angeles; *Vice-Presidents,* Drs. J. C. Wilson, Philadelphia, and H. S. Orme, Los Angeles.

AT the recent commencement exercises of the Stevens Institute of Technology, an address commemorative of the late President Henry S. Morton was made by the Rev. Edward Wall.

THE treasurer of the Hyatt memorial fund, to which we called attention last week, acknowledges the receipt of subscriptions amounting to $662. Further subscriptions may be sent to Mr. Stephen H. Williams, 10 Tremont Street, room 80, Boston.

A MEMORIAL tablet to commemorate the late Professor Hughes has been erected in the chapel at King's College, London, and a prize has been established to be called the Hughes Memorial Prize in Anatomy.

WE regret to record the death, through an accident, of Professor J. B. Johnson, dean of the College of Engineering of the University of Wisconsin. Born at Marlboro, Ohio, in 1850, Professor Johnson graduated from the University of Michigan in 1878, and later served as civil engineer on the United States Lake and Missouri River Surveys. He was called to the chair of civil engineering at Washington University, St. Louis, in 1883. While in St. Louis he conducted a large testing laboratory, at which the U. S. timber tests were made. In 1899 he accepted the position he filled at the time of his death. He was the author of 'The Theory and Practice of Surveying,' 'Modern Frame Structures,' 'Engineering Contracts and Specifications,' 'Materials of Construction,' etc. He was a member of the London Institution of Civil Engineers, the American Society of Civil Engineers, the American Society of Mechanical Engineers and a fellow of the American Association for the Advancement of Science.

MR. CHARLES T. CHILD, the electrical engineer and one of the editors of the New York *Electrical World*, died on June 23, at the age of thirty-five years.

DR. CARLO RIVA, docent in petrography at the University of Pavia, was killed on June 3 by an avalanche while engaged in scientific investigations on Monte Grigna.

MRS. PHOEBE A. HEARST, regent of the University of California, has presented to the Lick Observatory the sum of twenty-five hundred dollars, available in the year 1902, for the purpose of increasing its equipment. Previous gifts to the Observatory by Mrs. Hearst in the early nineties provided for the Eclipse Expedition to Chili in 1893, for a temporary fellowship, and for various other purposes.

MR. PIERPONT MORGAN has presented to the museum of the Jardin des Plantes a collection of precious stones valued at $10,000.

WE learn from the *Bulletin* of the American Mathematical Society that the Scientific Society of Harlem has proposed, as the subject for its prize in 1903, the investigation of the Japanese mathematics of the middle of the seventeenth century, and that the subject of the prize competition for the present year of the Société Scientifique of Brussels is 'to make a critical study of the works of Simon Stevin on mechanics, comparing them with those of Galileo, Pascal and other men of science of the same period.'

THE optical works of John A. Brashear Co., Ltd., have completed the 37¼ inch mirror for the reflecting telescope to be used by the D. O. Mills Expedition sent from the Lick Observatory to Chili, in determining the velocities of the southern stars in the line of sight. It is expected that the expedition will be able to sail from San Francisco within the next six weeks.

THE French Association for the Advancement of Science will meet at Montauban on August 7.

Nature states that the eighty-third meeting of the Société Helvétique des Sciences Naturelles will be held at Geneva on September 7–10. M. E. Sarasin is the president of the society, M. Marc Micheli and Professor R. Chodat vice-presidents, M. Maurice Gauthier and M. A. de Candolle secretaries, and M. A. Pictet treasurer. Correspondence referring to the forthcoming meeting should be addressed to M. de Candolle, Cour de St. Pierre, 3, Geneva.

THE department of state has received from the French embassy notice of the Sixth International Congress of Hydrology, Climatology and Geology to be held in Grenoble, commencing September 28, 1902. Papers will be read on the following subjects: *Hydrology.*

—(1) Action of mineral waters on the tissues; (2) practical methods of microbiological analysis applicable to mineral waters; (3) importance of complete chemical analysis of mineral waters with reference to mineral and organic matters to enlighten thermal medicine; (4) legal measures for protecting the exploitation of thermal and mineral waters; (5) hydromineral treatment of pulmonary consumption, (6) of skin diseases, and (7) of stomach complaints; (8) preventive action with children with constitutional tendencies. *Climatology.*—(9) Variation of respiratory exchanges as influenced by altitude, heat and cold; (10) meteorological conditions necessary to the installation of a sanatorium; (11) open or closed sanatoriums. *Geology.*—(12) Whether mineral waters intercepted by artificial means suffer variations of temperature according to the seasons; what variations; (13) relations of the principal thermal springs of Dauphiny with the geological nature of the soil; origin; (14) statistics regarding the mineral springs of Savoy and Dauphiny; (15) geological conditions and origin of the mineral waters of Oriol and La Motte (Isère).

THE Secretary of State will invite foreign governments to send delegates to the International Mining Congress, which convenes in Butte, September 1. The trunk lines of the United States will join with the Western Passenger Association in offering a rate of one fare plus two dollars for round trip to the congress.

THE president and council of the British Institution of Electrical Engineers gave a *conversazione* at the Natural History Museum, Cromwell-road, on July 1, to meet the members of the Incorporated Municipal Electrical Association and the foreign delegates to the International Tramways and Light Railways Congress.

A DEPUTATION from the British Institution of Electrical Engineers waited upon Mr. Gerald Balfour at the Board of Trade on June 19 to urge that something should be done to remove the impediments in the way of electrical industrial development. Amongst those present were Lord Kelvin, the Earl of Rosse, Lord Greenock, Sir Michael Foster, M.P., Sir Thomas Wrightson, M.P., Professor Perry, Professor Thompson, Lieutenant-Colonel Crompton, C.B., Major-General Webber, C.B., Dr. Spence Watson, and Mr. James Swinburne (president of the Electrical Engineers). Lord Kelvin introduced the deputation, and Mr. James Swinburne stated the case of the Institution. He was of the opinion that the staff of the Board of Trade which dealt with the regulations for the supply of electricity ought to be strengthened, and nothing less than a royal commission was required to deal with the whole question of electrical legislation. In his reply Mr. Gerald Balfour said that he fully recognized the importance of the subject and to a large extent sympathized with the deputation. He was afraid that it was undeniable that the electrical industry in England was behind America and Germany, and perhaps some other of the continental countries. It appeared that the really important question was not so much that of any impediments thrown directly by the legislature in the way of the development of the electrical industry, as the power which the legislature had given to the local authorities to veto schemes. He then reviewed the attempts that had been, and were being made, to remedy the condition of affairs and stated that the board was as anxious as the deputation to secure that the public interests should be properly served by the development of the electrical industry. With regard to the appointment of a royal commission he could not pledge himself, but he must consult his colleagues in the cabinet.

UNIVERSITY AND EDUCATIONAL NEWS.

THE corner stone for the new educational institution for which Mr. James Milliken gave $200,000 and an endowment of $20,000 a year has been laid at Decatur, Ill. Citizens of Decatur and the Cumberland Presbyterian Church added $300,000 to the endowment. It is to be known as Milliken University.

PRESIDENT HARRIS, of Amherst College, has announced a gift to the library of $25,000 by

Col. Mason W. Tyler, class of '62, as a memorial to his father, William Seymour Tyler, for many years professor in Greek in Amherst College.

The Institution of Mining and Metallurgy, London, has offered scholarships in mining and metallurgy to the following colleges:—The Royal School of Mines, two scholarships of £50 each; King's College (London), £50; the Camborne School of Mines (Cornwall), £50; and the Durham College of Science (Newcastle-on-Tyne), £50. These scholarships will be offered annually for three years. In addition to other work for the advancement of technical education in mining and metallurgy, the institution has submitted to the board of education a plan for affording practical experience in workshops throughout the kingdom to mining and metallurgical students.

We learn from the *British Medical Journal* that at the urgent request of the French Colony of Cochin China, the council of the medical faculty of the University of Paris has decided to found an institute of colonial medicine. The Governor-General of Cochin, M. Doumer, has granted a subvention of $10,000 a year. Provision will be made for special instruction in tropical diseases, but it is not intended to establish a chair for the teaching of the subject at present.

The council of King's College has passed a resolution by a majority of twenty-two to two declaring that, in view of the University of London act of 1898, every religious test as a qualification for office, position, or membership in or under the council of the college, with the exception of professorships or lectureships in the faculty of theology, shall, as soon as may be, cease to exist. While thus abolishing tests, the council declares its unwavering determination to maintain the connection of the college with the church of England, as provided for by its constitution.

It is understood that Dr. W. L. Bryan, vice-president of Indiana University and professor of psychology and pedagogy, will succeed Dr. Joseph Swain as president of the University.

The board of trustees of the University of Arkansas has elected Mr. Harrison Randolph, of Virginia, president of that institution.

Dr. Charles S. Palmer, professor of chemistry in the University of Colorado, has been appointed president of the State School of Mines at Golden, Colo.

K. C. Davis, Ph.D. (Cornell), has resigned the chair of horticulture in the University of West Virginia and the Experiment Station to accept the principalship of the Dunn County School of Agriculture and Domestic Economy, just established under provision of a new law, at Menomonie, Wisconsin. The new school, supported as it is by county and state funds, is without a precedent in the United States.

Dr. B. M. Duggar, of the U. S. Department of Agriculture, has been appointed professor of botany at the University of Missouri.

Dr. W. S. Johnson, of the State Normal School of Natchitoches, La., has been appointed head of the department of philosophy and pedagogy at the University of Arkansas.

Dr. Wilbur M. Urban, of Ursinus College, has been elected to the chair of philosophy in Trinity College and Mr. Henry A. Perkins, formerly of the Hartford Electric Light Company, has been made professor of physics.

Glasgow University has called Mr. Robert Latta, professor of moral philosophy, Aberdeen, to the chair of logic, in succession to the late Dr. Adamson. There were eight candidates for the position.

Dr. Karl Schwarzschild, associate professor of astronomy at the University at Göttingen, has been promoted to a full professorship, and Dr. Hillebrand and Dr. Leopold Ambronn, docents in astronomy in the Universities of Graz and Göttingen respectively, have been made associate professors. Dr. Wilhelm Trabert, associate professor of meteorology in the University at Vienna, has been appointed professor of cosmical physics at Innsbrück. Dr. Hugo Schwanert, professor of chemistry at the University of Greifswald, has retired.